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MODERN FARMING

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Illustrated Edition de Luxe

MODERN FARMING

A Practical Illustrated Guide

Edited by
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Volume One

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EDITORIAL PREFACE

OLDER men to-day, who have been farmers all their lives have seen so great a *revolution*—this is not too strong a word—in the business of farming, that the operation of the industry to-day bears little resemblance to the work of farmers at the beginning of the twentieth century. For example, production has been facilitated by the application of ever increasing mechanization and by a greater use of scientific knowledge about such things as manures, pests and animal diseases. Plant and animal stocks have been greatly improved by advances in breeding technique. At the distribution end of the industry there has been an ever growing realization of the importance of business methods in marketing and so the products of the farming industry have been handled with greater appreciation of principles which have long governed the commercial enterprises which put the products of the nation's mills and factories on the market.

Thus Modern Farming is carried on by skilled men under very different conditions from those in vogue in this great industry in the closing years of the nineteenth century. Almost every external aspect of the industry has undergone a profound change. Yet the soil remains the same, the human element in the countryside is the same; in their essentials stock and crops require the same foods for healthy development and they grow and mature in the same way. The use by the farmer of the great progress of science and economics, in our generation, as applied to agriculture is responsible for the remarkable transformation which has occurred in the use of our land for the production of food and in the business methods of buying and selling applied to-day to the goods which the farmer handles in connection with his work; fertilizers and machinery for instance coming onto his farm and the crops and stock that he has raised, going out to his customers.

Under the conditions of efficiency which characterize the best farms as a result of the businesslike application of recent discoveries and developments, no man can hope to be a successful farmer to-day unless he knows a great deal more about basic principles than his predecessors and is prepared, by due attention to his business, to make the fullest use of the means that modern research has placed at his disposal.

It was with these ideas as a background, that the series of successful books entitled *Teach Yourself Farming* was first planned during the Second World War so that when men once again entered civil life, after their enforced attention to martial pursuits, they might find, at their service, a handy set of useful and authoritative volumes to warn them of the pitfalls and to guide them in those very matters upon which the successful prosecution of *Modern Farming* must depend.

For the purpose of the present work these volumes have been re-edited and put into their present form as an ample guide to farmers, students and all lovers of the country way of life.

EDITORIAL PREFACE

We confidently recommend these books or sections—call them which you will—that make up the present work, because each is written by one who knows his business well, be it science or practice. Successful farmers, practical men, experienced scientists, teachers in our universities and agricultural colleges all contribute their knowledge, learning and extensive experience for the benefit of our readers.

The first section of volume one, entitled " Good Farming," is an essential introduction to the whole work and it is highly desirable that this part of *Modern Farming* should be carefully perused, especially by those who are not yet personally familiar with the intricacies of the farmer's life and business. In that masterly exposition of basic principles are incorporated warnings of the greatest importance to those who wish to take up a career in farming. So may loss and disappointment be avoided.

Modern Farming is, indeed, an intricate business. This guide will prove a useful work to all who are interested in it.

S. GRAHAM BRADE-BIRKS.

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SECTION I

GOOD FARMING

by

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Illustrations by

JOAN WINCHESTER *and*

KEITH FRAMLINGHAM

AUTHOR'S INTRODUCTORY NOTE

MANY popular fallacies have grown up regarding farming. Some of these originate from the repetition of catch phrases that, even if originally true, are not applicable under modern conditions. An outstanding example is the statement that farming is a way of life rather than a business. This is certainly not the case to-day. Not only is *Modern Farming* a business and one in which efficiency is essential to success, but the farming industry is one of the largest in the country, an industry that is unique in that it makes an enormous contribution to the national resources without reducing its basic store of raw material—the fertility of the soil. Another interest is to be found in the fact that the changes brought about by the war have made good farming—and its products, good foods—more important to this country than *very* cheap food.

Good farming in this section means farming so carried out as to produce the maximum economic output from the land. The term "intensive farming" will be used to describe those practices designed to produce a very high output, and the practice of using the minimum amounts of labour, cultivation and manure will be referred to as "a low standard of farming."

A most notable feature of British farming is its diversity. The differences which occur are primarily due to the fact that conditions differ from farm to farm. In some cases the differences are small, but in other cases they are considerable. Because of these differences unqualified statemen in connection with farming are rarely, if ever, c general application, and in this section emphas is laid on principles rather than on working detail

Does farming pay? This fundamental questic which is constantly being asked is answered c pages 1–5.

The factors essential to success in farming a discussed on pages 6–53 and 73–78.

Representative farms are described on pag 54–72 by well-known agriculturalists. The auth here wishes to thank these gentlemen for the assistance.

The training of farmers and farm workers dealt with on pages 79–81.

The future of British farming is briefly discuss on pages 82–84; while, for the benefit of those wl have no knowledge of farming, technical an colloquial terms (marked *) are explained in glossary at the end of the section.

Thanks are due to the *Farmer and Stock-Breed* for the use of the photographs from which Jo Winchester (J.E.W.) prepared her drawings. T illustrations signed K.F. are from origin drawings by Keith Framlingham.

The author has to thank Mr. V. R. S. Vicke Mr. James Wyllie, O.B.E., Mr. N. V. Hewis and Mr. W. J. Cumber, C.B.E., for kind reading through the draft manuscript, and f many helpful suggestions.

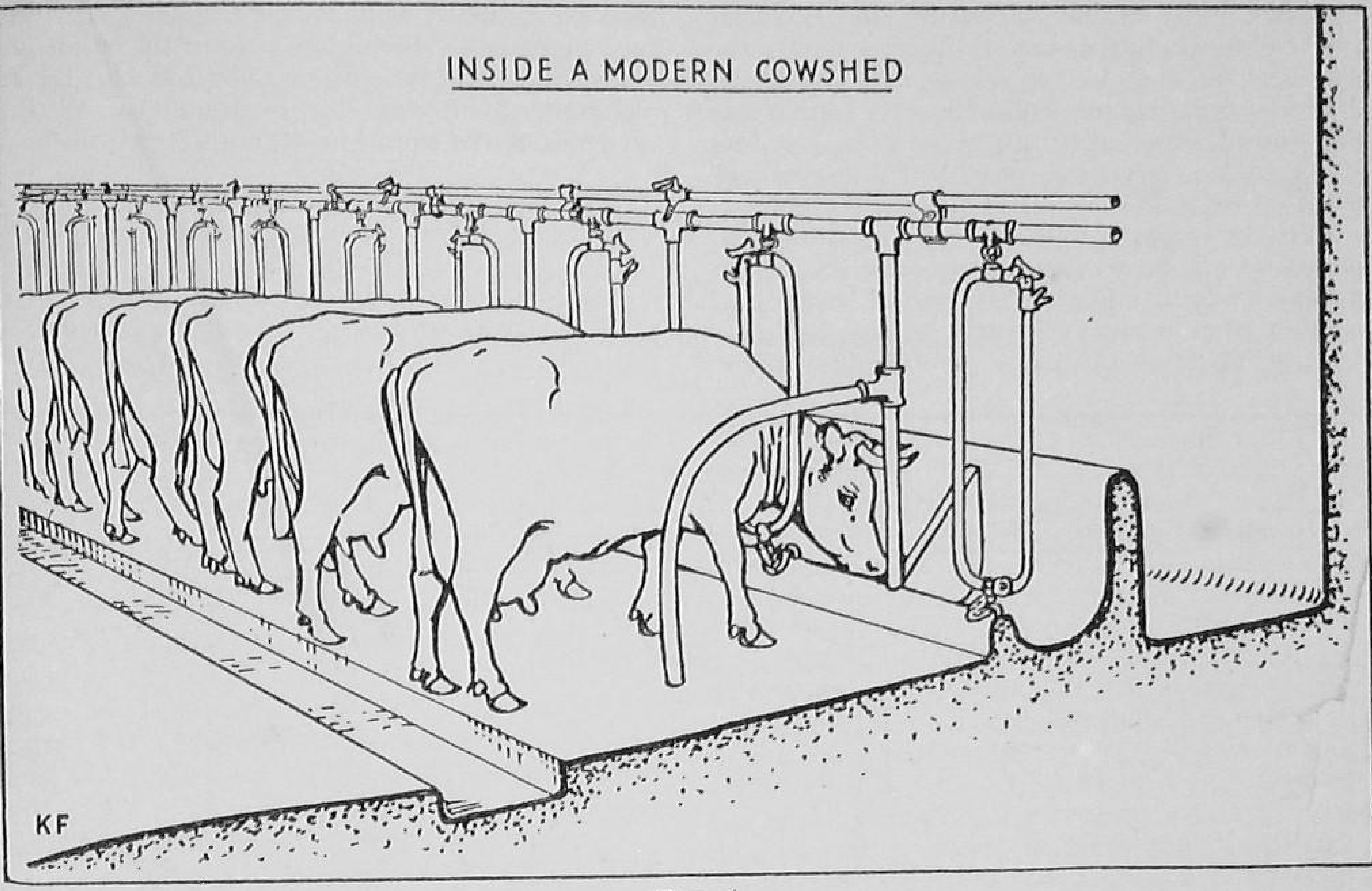


FIG. 1

DOES FARMING PAY?

Starting with a general note this section shows that farming pays four partners in the industry: the Nation, the Farm Landlord, the Farm Worker and the Farmer.

To obtain a true appreciation of the value of a business it is necessary to study its finances over a period of years. In the case of farming it is essential because three fluctuating factors dominate the situation. These three factors are: (1) The weather, (2) The incidence of diseases and pests, and (3) Fluctuating prices on the world's markets. The variable nature of the climate of the British Isles is common knowledge as is the fact that two or three bad years are liable to occur in succession. What is not so generally realised is that variations occur in the weather of countries like Canada, Australia and Argentina. A spell of wet weather in this country in August and September will invariably seriously affect the profit from corn growing, whilst a drought between the middle of April and June will cost dairy farmers and graziers hundreds of thousands of pounds. A good wheat year in Canada means the production of millions of bushels of wheat in excess of the average; three years' drought in Australia will produce a world shortage of mutton, whilst a series of favourable years will result in extra large supplies, and such fluctuations have repercussions upon the British Farmer. It is therefore essential to base an opinion regarding farm profits on a comparatively long period, and it will be convenient in this book to take the past fifty years into consideration. There are four partners in the farming industry—(1) The Nation, (2) The Farm Landlord, (3) The Farm Worker, (4) The Farmer—and it is necessary to consider how it pays each of these partners.

How Farming Pays the Nation.

Twice in our time British farmers have helped to save the nation from disaster. Both in the 1914–18 and 1939–45 world wars the U-boat menace was only defeated by the combined efforts of the sailor and the farmer. At the outbreak of both wars this country was buying the major portion of its essential foods from abroad. There were periods in both when the Navy was extended to the limit; merchant shipping was not available to replace losses, and this country was only saved from starvation by the fact that the high deficit in our food supplies was filled by increased production by our own farms. The story of the two wars was very similar. Farmers sank millions of pounds of capital in the industry in a stupendous effort to feed the country. To raise the money, reserves were liquidated and loans raised. The Land Army was recruited and trained to help replace men drawn for the armed forces, schoolboys and university students were taught to help harvest the crops, and the members of Voluntary Land Clubs to use their scanty leisure to advantage; and an almost unbelievable increase in output was attained. Between 1939 and 1943 four million acres of pasture were ploughed up and added to

the area under arable cultivation, by the latter year the home farms were producing nearly the whole of our bread corn, and practically all the domestic sugar ration, whilst the milk supply was maintained very largely on home grown feeding stuffs, and an adequate supply of potatoes and essential vegetables and fruit was produced.

Farming is a basic industry and everything produced on our farms is a direct increment to the national wealth. During the period under discussion, even in times of peace, farming has consistently made an invaluable contribution, for a must be regarded as a National asset. Turning for a moment to the human side of the question, a healthy, vigorous rural population can be an important factor in the maintenance of the constitution of the nation. It is still true to say:—

> "Ill fares the land, to hast'ning ills a prey,
> Where wealth accumulates, and men decay;
> . . . .
> But a bold peasantry, their country's pride,
> When once destroy'd, can never be supplied."
>
> *Goldsmith.*

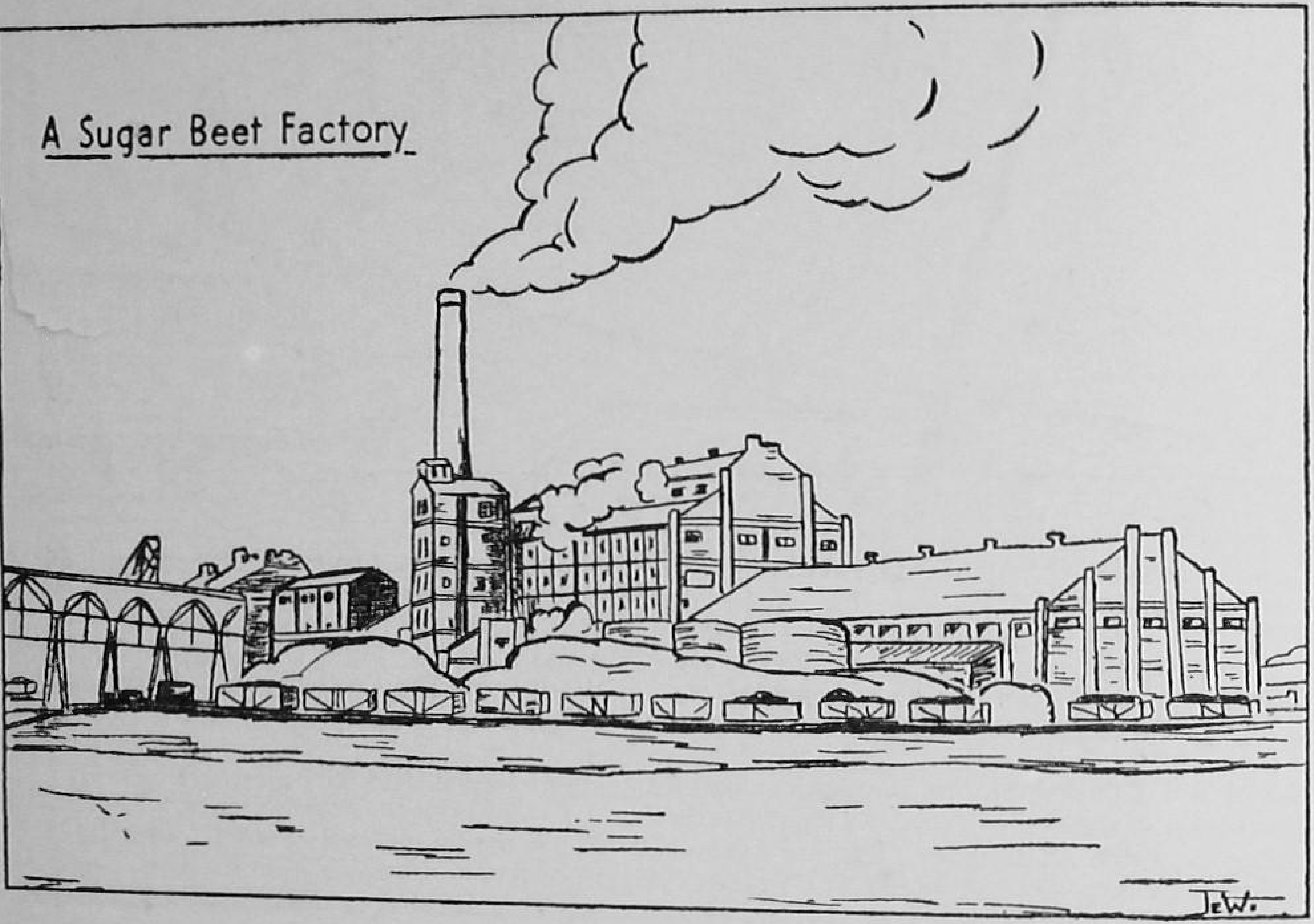


FIG. 2

very large amount of food has been produced annually. It is estimated that the average annual value of the output of England and Wales for the years 1930–1938 was 203 million pounds sterling. In addition, the industry has made an important contribution to the national health. The health of the nation and of the coming generation is determined to a very great extent by the supply of whole milk, and that commodity must be produced on the farms of this Island; whilst improvements are possible and desirable, it can be truthfully said that the British milk supply compares very favourably with that of any other country. The value of fresh fruit and vegetables is now universally recognised. Nutritional experts state that palatability is an important factor in human nutrition, and whilst quality had to give place to quantity as a war-time expedient, the unrivalled quality of the flesh of modern British live stock

In addition to the direct contribution made by farming to the National wealth, there is a number of related industries dependent on agriculture and providing urban workers with employment. The wheat grown must be ground by the miller, the barley turned into malt, sugar extracted from sugar beet, surplus vegetables preserved, and fruit canned or made into jam. The manufactures of artificial fertilisers and feeding stuffs are industries which not only provide employment, but are useful in that they absorb large quantities of by-products from other industries. The erection and maintenance of houses for rural workers and buildings for housing stock provide building operatives with an appreciable amount of work, while the mechanisation of agriculture proceeds rapidly and is providing an ever-increasing amount of employment for the engineering industry.

Although in peace-time agriculture has made an invaluable contribution to the national well-being, there is no comparison between that and the contribution made to the war effort. The reason is very simple; during the wars farmers were called upon to produce the maximum output, and because prices which were related to the cost of production were fixed, farmers were able to respond to the appeal. On the other hand, during the periods 1890–1914 and 1922–1932, the prices of agricultural produce were governed by world's markets and bore no relation to production costs in this country. The prices ruling were so low that intensive farming with its high output was only economic in Great Britain on very fertile land. On both poor and moderately good land it was necessary to keep production costs down to a minimum, and as a consequence large areas of arable land were laid down to permanent pasture or allowed to tumble down. Where three men were employed on a hundred acres of arable land, one man was sufficient on land under permanent pasture. The output was reduced in the same proportion, and a corresponding reduction occurred in the amount of employment provided in related industries.

A discussion of the National point of view would be incomplete without some reference to that of the most difficult of subjects—the outlook for the future. It is however quite safe to say that if the standards of agricultural production that were attained during the war could be maintained permanently it would help to solve the employment problem; for not only would the number of workers employed in farming greatly exceed the pre-war number, but there would also be a similar expansion in the amount of employment provided in all the related industries. But war-time standards of production can only be maintained in peace if there is a market for the output at a price which bears a reasonable relation to the cost of production. It should be added that in view of recent advances in rates of agricultural wages, production costs must now of necessity be higher than they were in pre-war days.

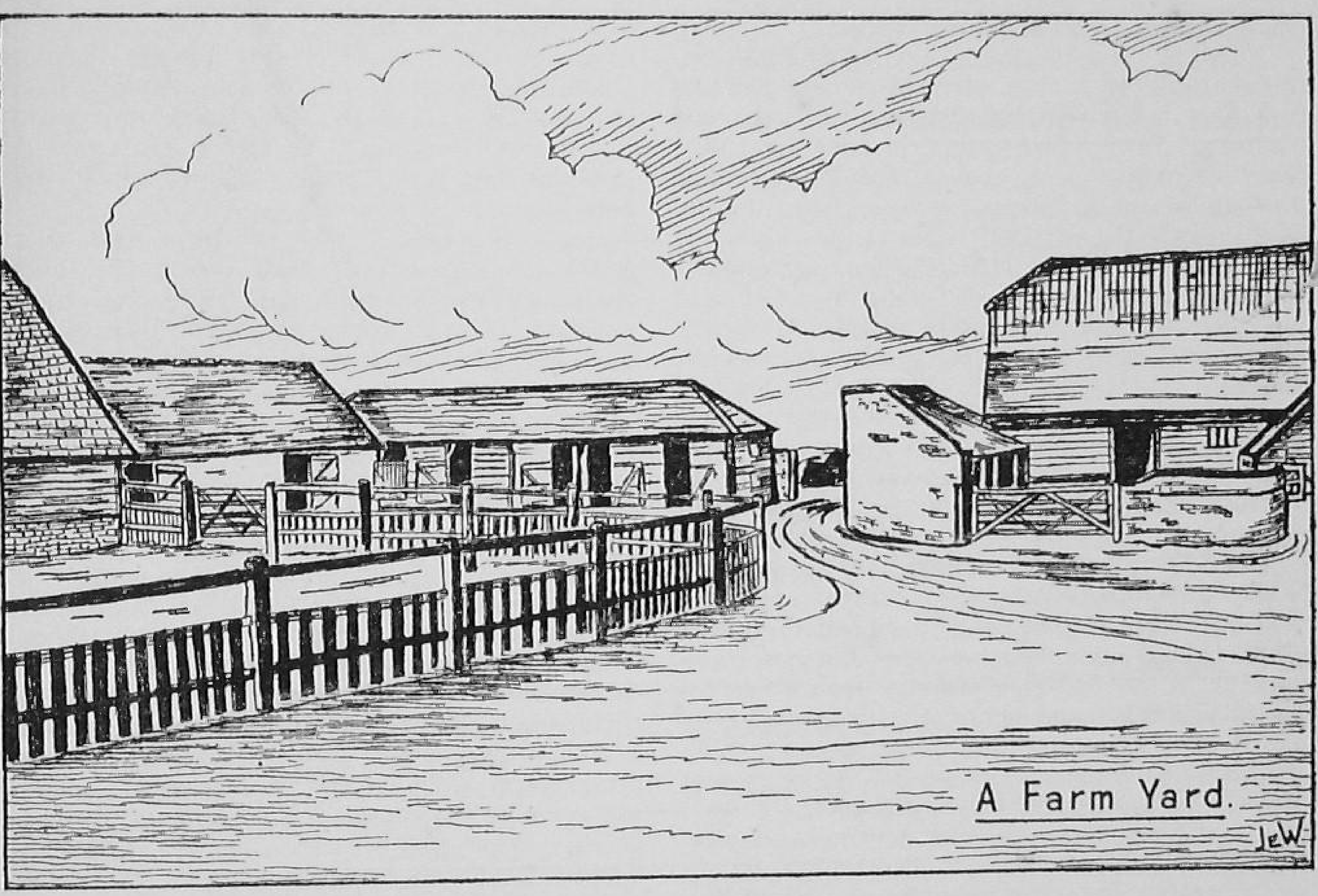


FIG. 3

How Farming Pays the Farm Landlord.

The Landlord's return is the net annual rent, and during the forty years 1900–1940, with the exception of the two war periods, farms have changed hands on approximately a 4 per cent. basis. The net annual rent is the amount which is left over after any fixed charges together with the amount necessary to keep the farm in repair have been deducted from the rent a good farmer is prepared to pay. The net annual rent has, during the years of peace, been about 4 per cent. of the freehold value of the farm, i.e. the price the farm would make if sold by auction in the open market.

It may be noted that in the preceding paragraph nothing is allowed for improvements to farm equipment. Buildings and other permanent

equipment sooner or later need replacement or remodelling, and such improvements may necessitate very considerable expenditure; if work of this type is to be carried out as and when desirable over a period of years the return will be appreciably reduced. Some owners who do such work regularly, say that their net return is not more than 2½ per cent. None the less the "good" owner will do the work and maintain the capital value of his farm; the "bad" owner, who refuses to spend the money, allows the value of the property to depreciate.

How Farming Pays the Farm Worker.

There are very few more encouraging developments than the change which has taken place in the lot of farm workers during the twentieth century. Taking wages first, in 1914 farm men were earning 18/- a week. The 1914–19 war brought about an increase in wages rates and the rise continued until 1921 when the weekly wage was about 46/- a week. Then the depression which occurred after the Corn Production Act was repealed caused a rapid fall in agricultural wages, which reached their low water mark, 27/11 a week in 1923–24. Subsequently there was a slow recovery which continued until 1939; in that year rates varying between 32/- and 39/- a week were paid in different parts of the country. Wages rose rapidly during the War until to-day the farm labourer is in a better position than ever before.

In addition to the wage increase, the working week has now been defined for every county, and all hours worked in excess of the allotted number must be paid for at overtime rates. Farm workers now get a statutory half-holiday each week, instead of as in the past having to work six full days. Horsemen, stockmen and shepherds who must of necessity frequently work on Sundays and Bank holidays are paid overtime rates for such work or given equivalent time off on full pay on another working day.

Piece work is not an uncommon form of hire for farm labour. Specialised workers agree to do so much work, such as hoeing, hedge-laying, draining, or thatching at a certain figure per acre, chain, or square (100 square feet), and the wages often amount to more than twice as much as the statutory minimum wages. On the other hand they have to bear, themselves, any losses of time through bad weather, which may at the same time make their work more difficult when they re-start. There may also be periods in which none of the particular work in which they are skilled is available.

Whatever the merits or demerits of this system, it has generally produced a high degree of skill; for instance, in the Fens there are workers who, with one woman helper, can plant up to 2,000 celery plants per hour and keep it up all day throughout the season. The same principle is often applied to stock tending; a bonus being paid on every lamb, pigling, calf or foal reared.

A certain amount has been done within recent years to improve rural housing, but in many districts there is still a great deal to be done in this direction; there are all too few villages with an electricity, gas, or water supply. The principle is now generally accepted that a rural worker should have an adequate garden. If there is not one attached to his house provision has been made for him to obtain an allotment. Small holdings have been made available for those who have the ambition to be their own master, and facilities have been provided for village children to obtain secondary education. Women's Institutes have developed social life amongst the wives of farm workers, and Young Farmers' Clubs are being formed to develop the interests of the younger generation. A Village Hall is now to be found in most villages and provides accommodation in which dances and other entertainments can be held.

But what is probably the most important of all is the development of rural transport. Forty years ago the only method of travel open to the majority of farm workers was the push bike, a method which was too tedious to tempt a man working 6 or 6½ days a week to go far afield. There are very few villages which are not now on, or within easy reach of, a motor bus service, and many farm workers now have motor bicycles.

How Farming Pays the Farmer.

Widely differing opinions are held as to what constitutes a fair profit from a business like farming, in which success or failure is largely determined by the weather. Whilst there is a lack of agreement regarding figures the facts are quite clear; but to appreciate them it is necessary to make a brief survey of the past fifty years. British farming suffered a terrible depression in the closing years of the nineteenth century, corn prices being at their minimum between 1890 and 1895, during the depression most farmers lost a considerable amount of money, and many went out of business in a bankrupt condition during the years 1890–1900. Corn prices rose slowly but steadily between 1895 and 1914, and during that period, most of those who survived the depression, made a living.

Prices rose to a very high level during the 1914–19 war and farmers as a body were very prosperous. Very heavy calls were made upon them, but they rose to the occasion and reaped a hard earned financial reward. The U-boat menace brought home to the British public the value of the farming industry, and during the war it became an accepted principle that the industry should be maintained in a prosperous condition even if legislative action were necessary to secure that objective. This principle was endorsed by the War Cabinet, and after the war the Corn Production Act of 1920 was passed with the object of establishing an economic price level. But it did not last long; in 1921 the Act was repealed, and

subsequently there was a disastrous fall in the prices of agricultural produce. The inevitable result was that farmers incurred serious losses in the years 1922–1930.

The prosperous condition of agriculture between 1916 and 1922 had a repercussion upon the value of land, farms which came into the market made very high prices and many owners were tempted to sell. As a consequence a large number of farmers were faced with the alternative of being deprived of their farms, with very little chance of ob··ining another, or of buying them. Many had ufficient money for the purpose and had to mortgage to provide a large part of the p price.

. of those who had incurred heavy mortgage liabilities to buy their farms, found during the 1922–1930 depression that they had shouldered a burden too heavy to carry; for they were then paying interest on capital which had disappeared as the value of their land fell. Unfortunately they were not alone in their misfortune. Farmers who were in business in 1914 made substantial profits between 1914 and 1922, and most of those who were not forced to buy their farms accumulated considerable reserves during that period, but these reserves were quickly lost in the 1922–1930 slump. Some, realizing the danger in time, made drastic cuts in their expenditure and modified their methods to meet the changed situation. They managed to avoid making too serious an inroad into their working capital and weathered the slump. Others failed because they did not retrench and reorganize sufficiently quickly and lost a large proportion of their working capital in addition to their reserves.

There was another group of men who suffered in the 1922–1930 slump, whose case is worthy of consideration, i.e. the ex-Service men who were attracted to farming. Some took a short course at an agricultural college, others spent a few months with a helpful farming friend. But even so, many not only entered their holdings before they had obtained adequate knowledge and practical experience, but did so when prices were at their peak. Some made small profits whilst prices remained high, but all incurred serious losses when the slump came. That also reduced the value of their stock to less than half the purchase price, and when they gave up their holdings, as the majority did, nearly all the money originally invested had been lost. Their experience may well be a warning to others, for obviously they made two very grave mistakes. Firstly, they entered farms without obtaining adequate knowledge and practical experience, and secondly, they started farming at a time when prices were inflated as the result of the war. Those who would take up farming would be well advised to follow the line of training suggested on pp. 79–81, and not to invest their capital in the industry too precipitately.

Between 1922 and 1932 arable land was laid down to grass* at an alarming pace, but the process was checked by the passing of the Wheat Act of 1932. Thanks very largely to the Mar ing Acts, good farmers were able with diffic to make both ends meet during the period 19 39, but the price level was not sufficiently gh induce farmers to plough up permanent past a few were able to pay off all or part of the accumulated during the 1925–30 depression, very few were able to accumulate reserves. When the storm broke in 1939 there was a general response to the call for increased production. That involved capital expenditure, and in many cases the money could only be found by borrowing. Agricultural wages were raised to make them compare more favourably with those of urban workers, and the marketing of farm produce was controlled, whilst prices were fixed at a level designed to cover increased production costs. They allowed a margin of profit, so that farmers who had adequate capital have in many cases been able to accumulate a small reserve during the war. But excess profits tax prevented profits being utilized to any appreciable extent for liquidating loans incurred to make increased production possible. Thus there was a danger that, those who borrowed money to enable them to increase their war-time output, might later find these loans a serious handicap.

It is apparent from the preceding survey, that whilst during the past fifty years, many good farmers made a living, their profits over the whole period were comparatively small—how small can be judged from the figures at the end of my discussion of " The Farm " on p. 14.

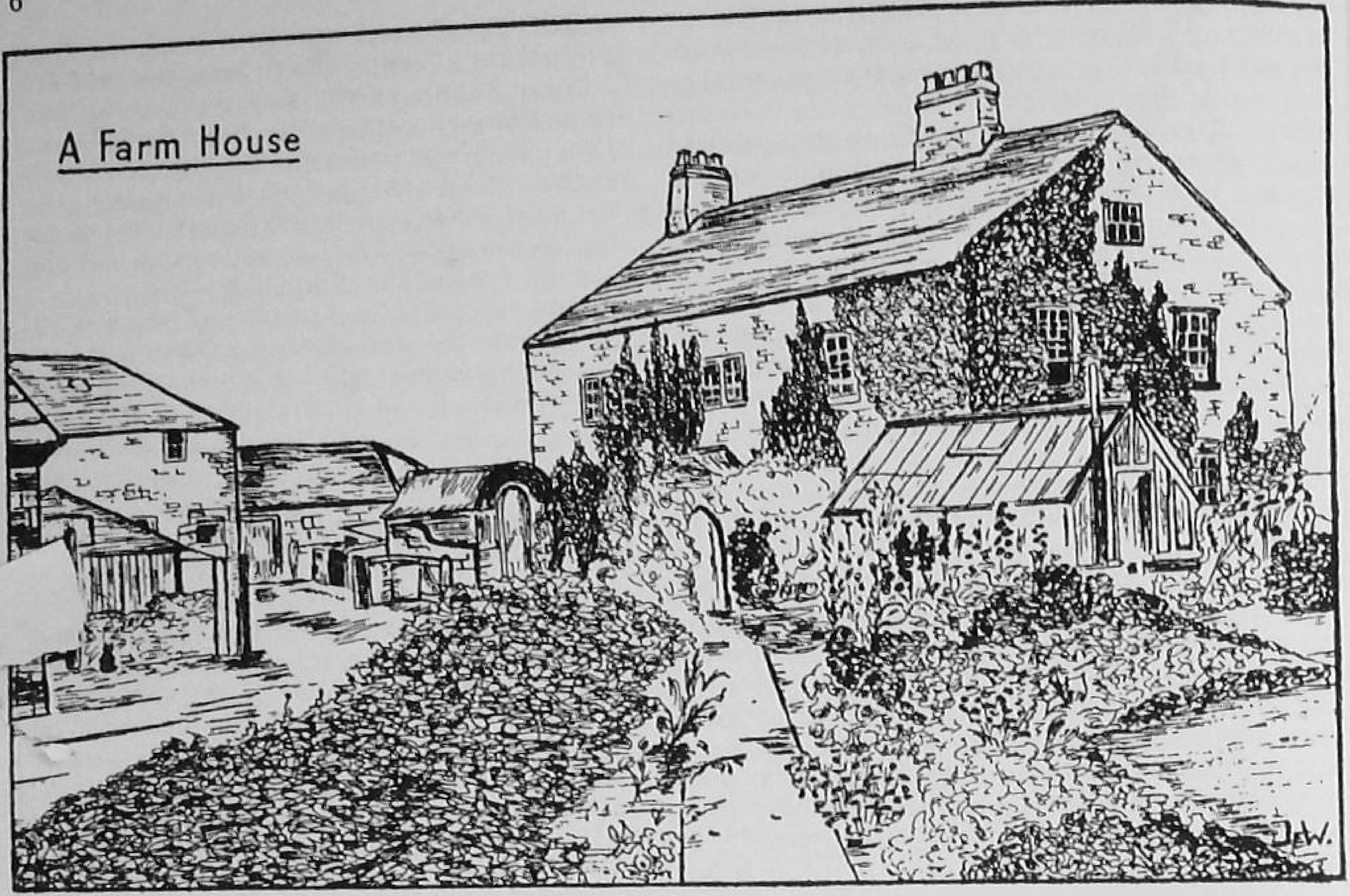


FIG. 4

THE FARM

Here is a chapter which deals with a number of points in connection with the farm itself, including—Owner-occupier and tenant-farmer. Factors influencing the value of a farm. Soil types, good and bad, soil improvement; "Which is the best soil?" Land drainage. Fences. Water supply. Farm buildings. Some general principles. A typical homestead, cost of buildings. Types of farm. Capital required. Returns.

SUCCESS in farming is determined by the farmer's ability to (1) obtain a farm on economic terms, (2) apportion his working capital* wisely, (3) manage his farm efficiently. Some of the points in connection with the apportionment of working capital are discussed on pp. 73–75. Farming practices are dealt with on pp. 16–44.

The farm may be purchased, in which case the farmer is referred to as an owner-occupier; or rented, when he is known as a tenant farmer. With regard to the comparative merits of the two methods, a man who owns his farm has complete security of tenure and obtains the full return from good farming, for in addition to his farming profits he reaps the benefit of any improvement he makes, and a good farmer will almost invariably improve the land. He can do as he likes as to permanent improvements, but he has to bear the whole expense of maintenance and repairs. With a given amount of capital it is possible to farm more than twice as much land as a tenant than as an occupying owner, and the extra area is unquestionably an advantage to a man with small capital. A tenant farmer has a reasonable amount of security of tenure, for he is entitled to compensation for disturbance if given notice to quit for any other reason than bad farming or the sale of the farm, and this tends to deter an owner from dispossessing a tenant. Also facilities for borrowing money to execute permanent improvements are such that many landlords will agree to any scheme if a tenant can show that it is an economic proposition, and is prepared to pay an increased rent to cover the cost.

But whether a farm is bought or rented it must be obtained at an economic price; for if too much is paid in rent, or the interest on the purchase price is too high, it may absorb any possible profit.

The earning capacity of a farm is to a very great extent determined by its situation, and the area and quality of the land. These are therefore the primary factors which govern its value. Buildings and equipment are necessary to enable the land to be used to the best advantage, but important as they are, there is a limit to the amount that can be expended on their construction and maintenance. Before deciding upon additions or alterations it is necessary to consider both initial cost and maintenance in conjunction with the financial return which is likely to accrue from their use. None of them has an indefinite life and it is desirable to repay fresh capital expenditure at the rate of 5–10 per cent. per annum according to the class of work.

The wide differences which occur in the system of farming followed by good farmers are due to the fact that in this country there is a considerable amount of difference between farms, no two are exactly alike, and in many cases substantial differences are to be found between adjoining farms. There is little land so bad that it cannot be put to an economic use providing it is farmed in the right way. The secret is to find the right line of campaign and then to execute it soundly. Conversely no farm is so good that it will remain profitable for long if badly farmed.

The income of a farm is derived from the sale of crops and stock which are directly or indirectly the product of the soil. Thus the value of a farm is primarily determined by the situation and the area, and the quality of the land it contains, and the revenue partly by these and partly by the skill with which the land is cultivated. It is, therefore, very necessary for a farmer to have an intimate knowledge of the soil, and fortunately the research work of the past fifty years has thrown a considerable amount of light upon this all-important subject.

Types of Soil

It is customary for farmers to refer to different types of soil by terms which are correlated with outstanding features or with composition.

The basis of soils is an aggregate of clay, silt, sand and humus in different proportions. Lime is the other soil constituent of special interest. The proportion of the various constituents present determine some of the soil characters that concern farmers. The mineral constituents predominate in the common soils of this country, in them the proportion of lime is generally small. In many there is either no free lime, or a quantity which is very much below the level desirable in fertile land. Such soils need periodic applications of lime.

If the proportion of clay is high it exerts a dominant influence on the character of the soil, and is known to the farmer as a clay soil. The charge in respect of the power required to draw implements is an important item in farming costs, and, as the basic work is done with the plough which until recent years was drawn by horses, it became the practice to describe soils by the number of horses in the plough team. At least three horses are required to draw a single furrow plough through clay soil, and it is therefore known as three-horse or heavy land.

The capacity of a soil to retain moisture is another important character. Clay soils retain moisture for a comparatively long time, and are therefore known as wet soils. Owing to their wet nature they warm slowly under the influence of the rising temperature in the spring and early summer. As a consequence the crops they carry start growth late, grow slowly in the early summer and ripen late, facts which have earned for clay soils the designation of late soils.

When the proportion of clay is low, sand and silt become the dominant constituents and we have what is known as a sandy soil, a type which is opposite in all respects to a clay soil.

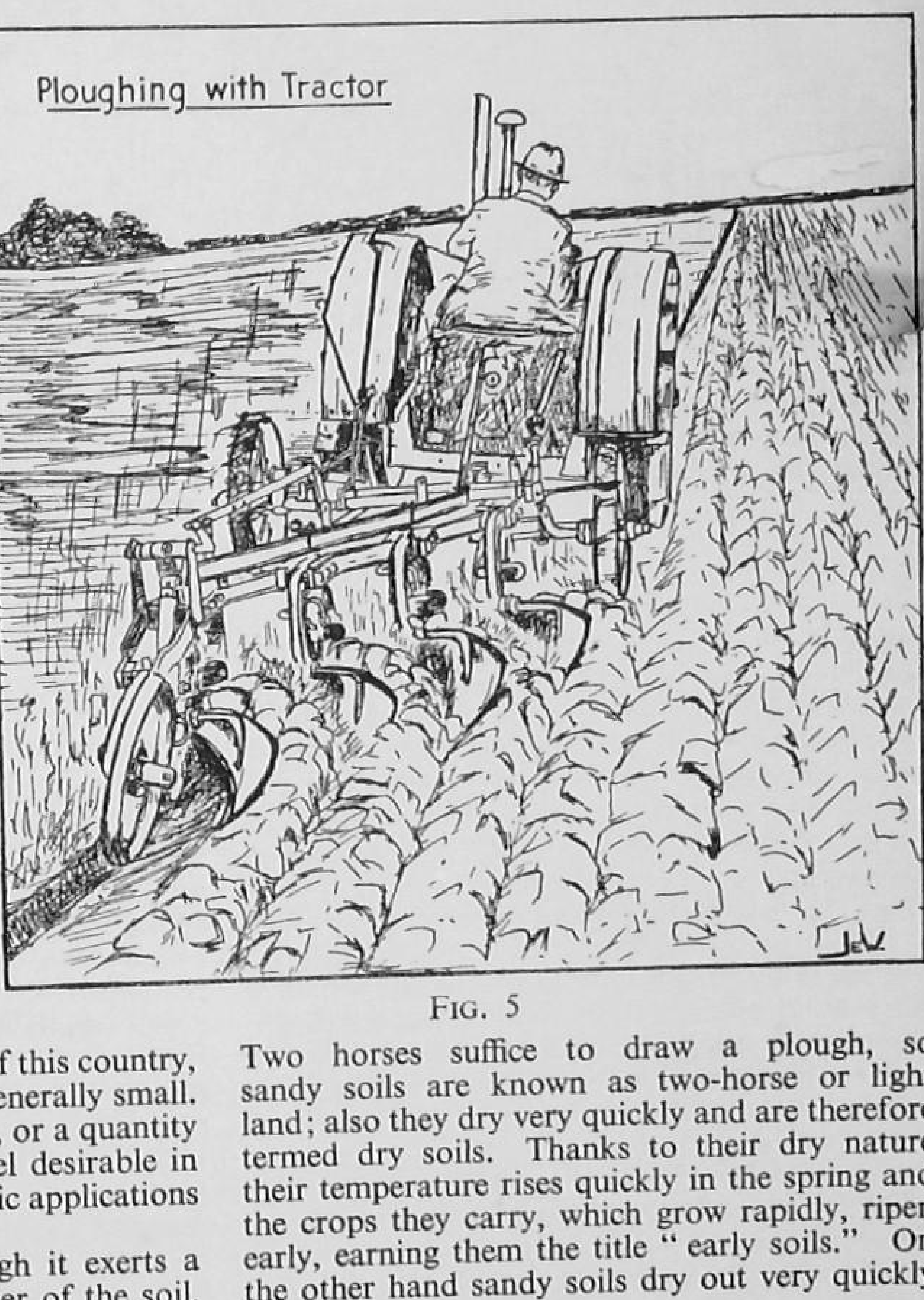


FIG. 5

Two horses suffice to draw a plough, so sandy soils are known as two-horse or light land; also they dry very quickly and are therefore termed dry soils. Thanks to their dry nature their temperature rises quickly in the spring and the crops they carry, which grow rapidly, ripen early, earning them the title "early soils." On the other hand sandy soils dry out very quickly in a drought.

Earliness is a character of great importance to market gardeners because the first fruit and vegetables which come on the market always make a very high price. Indeed, some amount of premium is attached to early marketings of most crops. It is a character which is influenced by situation and aspect as well as by the type of soil. The earliest crops are obtained from sandy soils which are situated either on the side of a hill which has a gentle slope, or within the area

influenced by sea breezes and have a southern or south-western aspect.

Intermediate between clay and sandy soils are the loams, a very useful group of soils which are light enough to be easy to cultivate, and while containing sufficient clay to enable them to withstand drought are not as a rule unduly wet.

In the Fens of the eastern counties, soils are to be found which contain a large amount of humus. Dark in colour such soils are wet and boggy if badly drained, but if provided with efficient drainage they are very fertile; light to cultivate, they produce heavy crops without excessively heavy applications of manure. Soils of this type are known as fen or peaty soils. Small areas are to be found in many parts of the country.

If the percentage of lime in a soil is high it becomes the dominant constituent and the soil, which is known as calcareous, is light working and often dry, but liable to set like cement if worked when wet. Soils of this type are a typical feature of the Chilterns, Downs, Cotswolds and parts of the Pennines.

A discussion of soils would be incomplete without some reference to the all important question of depth. It has been customary up to comparatively recent years to use the term soil in this country for the uppermost layer of land, the part which is cultivated on arable land and the corresponding layer on pastures. The similar material immediately below was referred to as the subsoil. No definite boundary was recognized between soil and subsoil or between the subsoil and the material upon which it rested, which was usually referred to as rock. In some cases the "soil" described as a "thin soil" would be not more than 3–4 inches in depth, in the majority of cases it ranged between 7 inches and 10 inches, and in a few, described as deep soils, it was as much as 24 inches deep. The layer referred to as subsoil varied between 6 inches and many feet in thickness. At the best the layers referred to as soil and subsoil were undefined, and the position was further complicated by the fact that the terms were not always used consistently. In some cases the two layers were referred to as "the soil."

Modern soil science has clarified the situation. The term soil is now used for all the material in which plants grow, and since we know that in many cases roots go down many feet into the ground the term of course includes the layers formerly known as the subsoil.

The ordinary farm crops need a soil several feet deep to make possible the aeration and drainage necessary for the development of a normal root system, and other things being equal the fertility of a soil is proportional to its depth. Liberal manuring will not compensate for lack of depth—on the contrary it is only in deep soils that manures will produce their maximum effect.

There are other natural features which exert a considerable influence upon the value of the soil. For instance the incidence of late frosts is liable to be high in the bottom of valleys, whilst the maximum wind pressure is felt at the top of hills and wind will strip fruit trees and lay* corn. Land which has a very steep gradient is difficult to cultivate and usually drains unduly rapidly. A few trees are useful in pastures for the shade which they afford to cattle, but are an unmitigated nuisance in arable fields. Woods and spinneys help to make the landscape picturesque and provide cover for game, but are liable to harbour rabbits which take an undue toll from surrounding fields.

Good and Bad Soils.

The term "good soil" is applied to land which is in a high state of fertility, and bad soil to that of which the fertility is low, but although in universal use the terms are not well chosen because even very fertile soils are not good for all purposes while the poorest land can be put to an economic use if it can be obtained at a sufficiently low price. This point is very well illustrated by the case of a poultry farm. Very fertile land with an annual value of £4 per acre is actually less suitable as a site for commercial egg production on the intensive system than the poor thin land on the chalk downs, which is frequently not worth 10/- per acre per annum.

Soils which are in a high state of fertility are invariably deep, sufficiently retentive of moisture but well-drained and rich in plant food. Some, such as the fen soils referred to above, are naturally fertile, containing very large reserves of plant food (which represent the accumulation of hundreds of years) from which the skilful cultivator can draw. In his hands these soils can be maintained in a very high state of fertility and be made to carry heavy-yielding crops with the expenditure of a comparatively small amount of manure. They are very valuable soils of which unfortunately there is only a small area in this country. There are, however, large areas of land which though not naturally fertile, have become highly fertile because they have a responsive soil which, because they have been well farmed for a period of years, have accumulated a considerable reserve of plant food. If liberally manured and well cultivated such soils will produce heavy-yielding crops, but their fertility is largely artificial and can only be maintained by consistent intensive manuring; they will deteriorate quickly if the standard of manuring and/or management is reduced.

During the period preceding the 1939 world war, prices of farm produce were low and it was necessary to keep production costs down to a minimum; then the improvement of poor land was only practicable in specially favourable situations. But, both in wartime and in this post-war period, maximum production is the order

of the day, and in most cases the price level renders it an economic proposition. There are two classes of poor soils: (1) those which have a disability which cannot be rectified, and (2) those which owe their poverty to the cumulative effect of a period of a low standard of farming.

Soils which have some natural disability, such as those which are too thin to permit the development of a normal root system, are a difficult proposition because their productive capacity is too low to warrant any appreciable expenditure. But if the amount expended is limited judiciously and cultivations and manuring are well chosen, many such soils can be gradually profitably improved. If badly farmed, soils of this type are very liable to revert to prairie* condition.

Where poverty is due to a period of a low standard of farming a clearly marked improvement must accrue from good farming. Money spent on soil improvement is capital expenditure, and though an attractive rate of interest is frequently earned on the money invested, a number of years must of necessity elapse before the capital can be recovered. The amount which must be invested is rarely less than £5 per acre, and in many cases amounts to £10–£15 per acre.

Which is the Best Soil?

No soil is the best for all purposes. For example, a deep, well-drained fertile loam is ideal for many crops, but there are others, such as malting barley, for which a less fertile type of land is more suitable. The question as to which is the best soil is purely academic except in the case of specialized farms, and this for two reasons. In the first place, it is one of the characteristic features of the British countryside that several different soils are frequently to be found in a small area; so much so that two or three soil types frequently occur on a farm, and even in one field. The second reason is that commercially the value of land is determined by its price, and there is generally keen competition for very fertile land, and that, as a consequence, makes a relatively high price. On the other hand there being less competition for poor land it can often be acquired at a price which makes it the more attractive investment.

To pass to the question of equipment—wet land must be drained, and pastures must be fenced and provided with water to enable the land to be used to the best advantage; while buildings and house ought to be suitable and all must be maintained in a serviceable condition. Oddly enough the best farmsteads are often found on the poorest soils; and the converse is often true.

Land Drainage.

The value of land drainage has long been recognized, and a considerable portion of the wet land of this country has been drained more or less efficiently. But there is still some land which needs draining and existing drainage systems that sadly need overhauling. A great deal of drainage work was done during the war, but the work done only cleared away part of the arrears, for taking the country as a whole the returns from farming during the past fifty years have been too low to permit any appreciable expenditure on land drainage. Drains must receive periodic attention if they are to be maintained in good working order.

Surplus water is removed from the soil at two stages. When torrential rain falls on heavy land the water comes down faster than it can soak into the soil. Whenever possible it is desirable to prevent pools of water collecting on the surface. Surface drains are, therefore, provided to enable the surplus to drain away. The first units in the surface drainage system are what are known as water furrows.* These are formed by ploughing one furrow and spreading the furrow slice.* On arable land furrows are drawn within 48 hours of drilling. They are sited so as to run down and slightly across a slope. Naturally they are connected with a ditch at the lowest point. Ditches are the second units in the surface drainage system. They are usually sited on the verge of fields and linked up with a convenient water course.

In some cases the cultivated layer of soil lies upon porous substrata, any surplus water that such soils may at any time contain quickly drains away. But there are others which lie on impervious substrata and are liable to become waterlogged unless provided with land (or under) drains. These are formed by making an open channel from 18 inches to 3 feet below the surface with a suitable outlet into a ditch. What are known as mole drains can be formed in heavy soil by drawing a metal " mole " through the soil; they are cheap and will last for about ten years under favourable conditions. In the standard method, pipe drains are formed by excavating a narrow channel and laying drain-pipes end-on-end at the bottom, the earth being subsequently filled in. This cost £16–£20 per acre before the war, but if properly constructed the drains have a life of at least twenty years.

Maintenance of field drains is one of the routine winter jobs of the farm. The position of the outlet of every drain should be known, it should be inspected periodically and any obstruction which may have accumulated removed. Silt is deposited at the bottom of ditches and tends to accumulate at a surprising speed; in a few years a sufficient depth would be formed to bury the outlets of drains. Ditches must, therefore, be dug out periodically, and on well-managed farms in wet districts it is customary to go round all the ditches annually. The drains themselves do not need attention unless they get broken or blocked, evidence of which is quickly provided by the appearance of a boggy patch, and frequently by a puddle of water which will not drain away.

When this occurs the drain must be opened and the broken pipe replaced or obstruction removed. On outlying heavy land farms, it is a wise precaution to keep a small stock of drain pipes in hand for emergencies.

Some wet soils have been improved considerably during recent years by subsoiling or panbursting, an operation which breaks up the layer of soil just below that normally broken by deep ploughing. Subsoiling can be done when the land is ploughed by means of a special steel tine fitted behind each plough body or by a special implement—the subsoiler. Considerable power is needed because the work is at greater depth than ordinary deep ploughing.

FIG. 6

Fences.

One of the most characteristic features of the English lowlands are the thorn hedges, and of the hilly districts, the stone walls, which form the boundaries of the fields. They are as useful as they are picturesque. The law is that every man must fence against his own stock, but the custom is that the onus to keep a boundary fence in repair lies on the farmer who occupies the farm to which it belongs. It is a custom which is almost universally honoured and he usually accepts it as being his own fault if his neighbour's stock breaks through a gap. The hedge and ditch are considered to belong to the field which adjoins the hedge, i.e. your ditch is usually in your neighbour's field. By custom the owner is allowed the use of the nine links extending beyond the root of his hedge to enable him to renovate his ditch.

It should here be noted that the law is that an owner is liable for damage if an accident is caused by unattended stock being on the high road. Such accidents are very liable to occur in these days of fast moving traffic, and it is a very serious matter for a farmer to allow road fences of pastures to remain in a bad state of repair.

The value of good internal fences is often not fully appreciated. Without them stock are liable to stray and damage crops, while controlled* grazing, which produces the maximum return from pastures is impossible. It is a comparatively easy matter to keep thorn hedges in a good state if they are layered periodically and trimmed occasionally in the intervening years. But hedges allowed to grow unchecked get thin at the bottom and then worse than useless as a fence against stock. There is a parallel in the case of stone walls, which can be kept in a reasonable state of repair with an insignificant amount of *annual* attention, but if neglected for several years in succession are liable to get into such a dilapidated condition that it becomes a costly matter to renovate them.

The extension of the ley system frequently makes it necessary to fence fields which have previously not been enclosed. A fence made from sheep wire on light posts will turn sheep, is cheap and will last for three or four years, but it will not suffice against cattle. If, however, a

single strand of barbed wire (or an electric fence) is erected at breast height a yard inside the sheep wire fence, the combination will hold both sheep and cattle.

The electric fence—a single strand of wire, hung on insulating reels attached to light posts, and charged continuously from a six-volt battery is a useful cheap fence which can be quickly erected. Stock which have received a small electric shock are careful to avoid it, and the fence is quite effective if fixed at the right height, but the height must be adjusted according to the type of stock against which it is desired to fence.

The small and irregular size and shape of fields is one of the features which almost invariably invokes adverse criticism from visitors from abroad. As far as pasture is concerned irregular shape is only a disadvantage when a hay crop is taken. It is better policy to have a number of small pastures than a smaller number of larger enclosures, because a number of enclosures makes it possible to adopt "controlled"* grazing and to segregate different types of stock, and this is always an advantage. It is a different matter with land devoted to arable crops. Here, small irregular shaped fields are a distinct disadvantage because they cost much more to cultivate and upon them progress is slower than in the case of large square or rectangular fields. In most cases, however, before fields can be remodelled, ditches must be filled in and boundary fences grubbed and replaced at a cost which makes alteration uneconomic. But the boundary fence of arable fields should be straightened and adjoining arable fields joined together whenever it is practicable.

Water Supply.

An adequate supply of good water is invaluable to a farm. The cost of carting water any distance very soon becomes heavy, but even that is not a full measure of the extent to which a stock-farm is handicapped by the absence of drinking water from the pastures. Moreover, crops like fruit and potatoes, in the cultivation of which spraying is a routine practice, cannot be grown to any extent on farms which have no adequate water supply. Unfortunately, in some of the drier parts of the country there are large areas in which few, if any, farms have an adequate supply. To lay water on to these districts would entail a heavy expenditure which does not make the project very inviting to the private investor, but it is one which from the national point of view is worthy of serious consideration.

Farm Buildings.

Shelters and housing for livestock, as well as storage barns and accommodation for preparing food, are important items in farm equipment even in the south and south-east of England, where on light land stock can be wintered out of doors. In the wet climate of the west and the more rigorous climate of the north substantial buildings are desirable. The accommodation afforded by the farm buildings frequently governs the system of farming for two reasons:—(1) It controls the numbers and types of live-stock which the farm can carry; the outstanding examples of this are: First, the question of keeping milking cows, a possibility which is determined by the presence or absence of a cowshed, conforming to modern requirements; and second, the problem

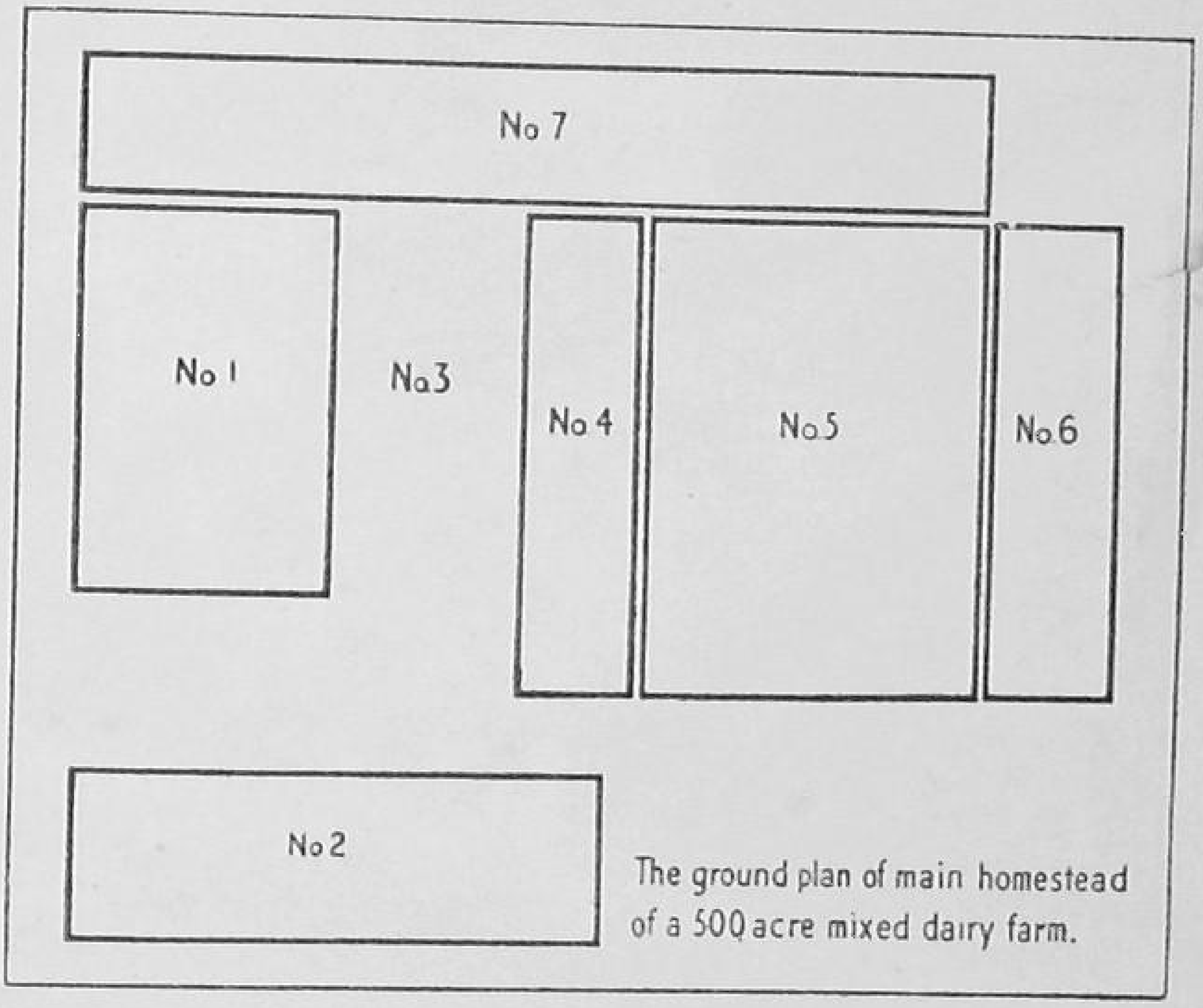


FIG. 7

concerning the number of cattle which can be kept during the winter months, and this is of course governed by the capacity of the buildings. (2) The extent to which machinery can be employed is largely dependent upon the accommodation available, because modern machinery needs protection from the elements when not in use.

A superficial study of the buildings on an ordinary farm best indicates the type of structures required, and also some of the problems which confront those who wish to remodel old buildings. Figure 7 shows the ground plan of the main homestead of a 500 acre mixed dairy farm. This set of buildings has been remodelled twice during the past fifty years, and on both occasions old buildings were partly demolished to make room for the new structures. The roof of building number 5 is constructed of Yorkshire boards,

and number 2 is a corrugated iron structure, the remainder have brick walls and tiled roofs. Building costs differ greatly in different localities, but in order to give an idea of the amount likely to be involved in a rebuilding scheme, a builder's estimate (prepared by Mr. J. Earll, M.B.E., of Wye) is given of the cost, at 1939 prices, of erecting each building. Timber and corrugated iron can of course be used to reduce constructional costs, but it is as well to bear in mind that a small initial outlay is almost always correlated with high maintenance costs. Scores of dilapidated buildings are to be found scattered over the

Number 6 is another remodelled building. Originally it was a cowshed which failed to conform to the requirements of the Milk and Dairies Order, so it was replaced by a modern cowshed and the discarded structure converted into a row of loose boxes. The latter are invaluable on any farm, and there is rarely enough of them. Sometimes it is possible to remodel an old cowshed and to make it comply with the regulations, but it is always more satisfactory to build a new house, and, though the original cost of the latter is invariably greater than that of renovating an old building, a new house is often

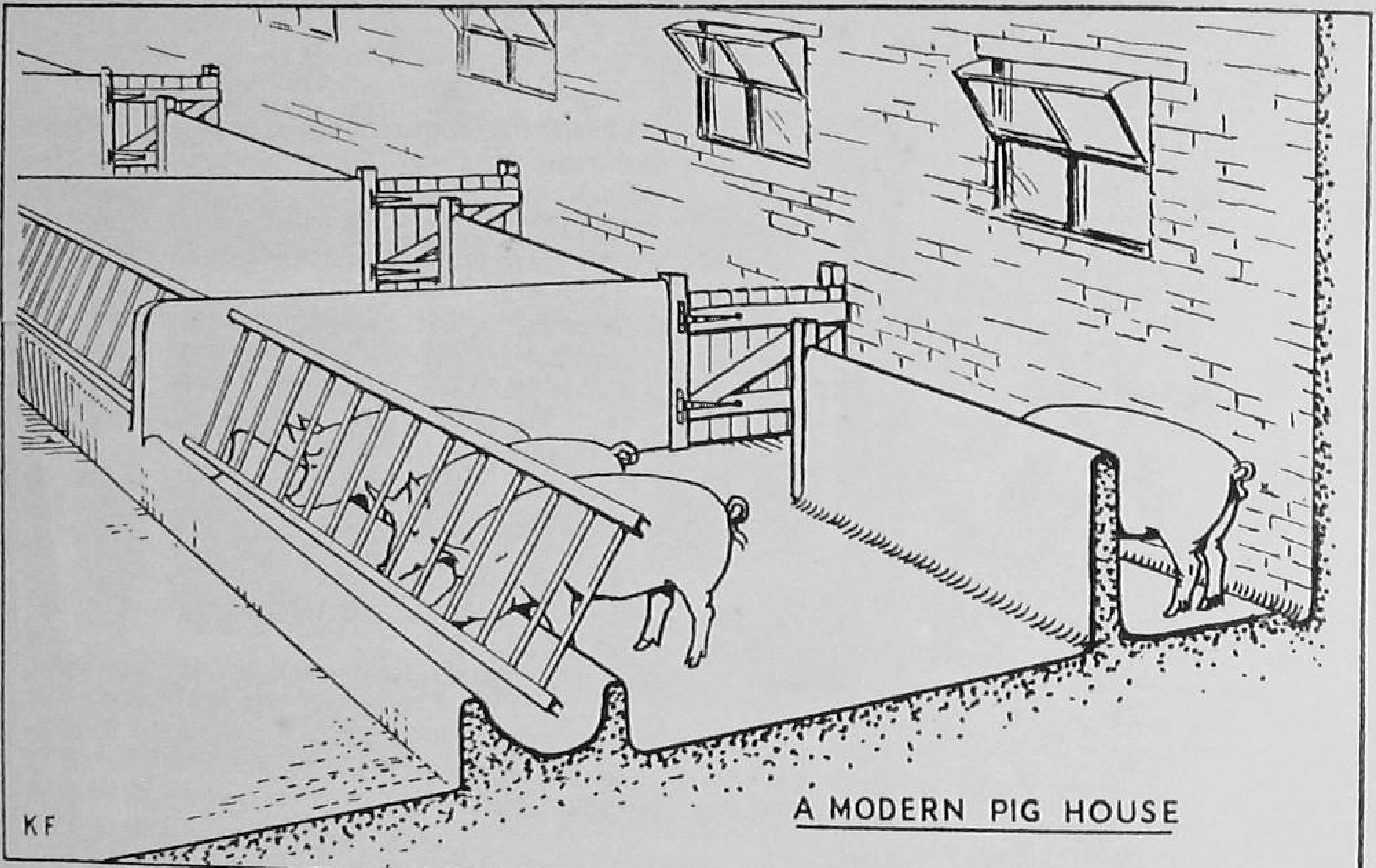


FIG. 8

countryside bearing a dismal testimony to the difficulty of maintaining cheap structures in a satisfactory condition. Changes are liable to occur that make it desirable to alter the system of farming. Therefore, when planning anew, or remodelling an old building, it is wise to make the shell sufficiently large to permit the building to be adapted for other purposes.

The building number 7 was part of the original structure and was remodelled about fifty years ago. In two-thirds of this building are two floors; the upper is used as a food store and granary for which purposes it has the disability of not being rat proof. On the ground level there is a concrete floor throughout, and this floor is divided into three compartments: (1) mixing room and store, (2) an engine room, (3) a general store. All these are essential on any farm. The 1939 estimate for this building was £1,700.

cheaper in the end. The estimated cost of five loose boxes similar in size to this building was £600.

Number 5 is a covered stock yard which was erected about thirty years ago on the site of an open yard. The open type of yard is found on most farms, but although to cover a yard effects an economy in manure, very few owners are prepared to face the cost. The 1939 estimate for building number 5 was £420.

Number 4 is a farm stable, chaff house, and harness room for ten horses and was part of the original homestead. Tractors have displaced three pairs of horses and the accommodation provided for them can now be utilised for other purposes. This is a state of affairs frequently to be found in connection with farm stables at the present day. The estimated 1939 cost of the existing stables, chaff house and harness room was £1,000.

Number 3, now a court yard, was formerly an open stock yard, the alteration being necessary to conform with the requirements of the Milk and Dairies Order, which stipulates that farm-yard manure must not be allowed to accumulate in such close proximity to a cowshed.

Number 2 is an example of what is one of the most important buildings in a modern homestead —the implement shed. This one was built thirty years ago to replace an old cart-shed considered to be inadequate, but even so it does not provide sufficient accommodation to-day. As on a large number of farms the existing accommodation has been rendered inadequate because the use of machinery has developed so much in recent years. The estimate for the 1939 cost of this building was £1,200.

Number 1 is a modern cowshed (figure 1), a type of building essential to a dairy farm. If whole milk is sold the cowshed must conform to the requirements of the Milk and Dairies Order. The cowsheds on many farms have been remodelled or replaced within recent years, but there were some, where before the war, the milk was produced for butter or cheese making, which need to be replaced or renovated to make them conform with modern ideas. The building on this farm is not unduly elaborate, none the less the 1939 estimated cost was £1,550.

In addition to the buildings enumerated above the farm under discussion possessed two excellent Dutch barns in the rick yards. These very useful structures, of which more are badly needed, are comparatively low-priced substitutes for the oftimes picturesque corn barns of the fifteenth to nineteenth centuries.

As is the case on many farms the accommodation provided for pigs in the original buildings did not conform with modern ideas, and some fifteen years ago a new piggery was built. This was a cheaply constructed set of wooden buildings with concrete floors, consisting of ten breeding pens, modern fattening house, a food store, a weighing pen and a loading ramp. These buildings cost £1,200, the cost of the breeding pens was £20 per pen, the food store £200, and the fattening house, £750.

The Farm House.

Some of the older farm-houses are genuine antiques which ought to be carefully preserved, but the majority which date from the middle of the 19th century have no particular merit. Often they are unduly large, having been built at a period when domestic labour was plentiful. Frequently no attempt has been made to modernize them because they are unproductive, and if capital is limited it is a better investment to spend money on stock, or farm equipment. This is as it should be, for the reverse policy is likely to lead to disaster. Upon the other hand if money is available, without prejudicing the working capital or the farm equipment, and only on that condition, it is an advantage to provide a farm with a modern house, because although such a house does not add to the earning capacity of a farm, it does make the property more attractive and in that way may increase its capital value. Further small expenditure on such things as a modern hot-water system, or installing electric light will frequently increase the capital value of a farm to an extent which is out of proportion to the amount expended. Then again occasionally where there is a shortage of cottages, the present farmhouse could with advantage be converted into two or three houses for farm-workers, and be replaced by a small modern house. One was inspected which could have been converted into two good cottages for about £300.

Cottages.

Then there is the question of cottages. Without discussing that very debatable point—the tied cottage—it may be pointed out that the potential capacity of a farm is in many cases governed by the supply of labour. That in turn is determined by the available supply of modern cottages—or, perhaps one should say, houses; and there are many districts in which the number of modern houses is inadequate to house the labour necessary to farm all the land well. Further, if good labour is to be obtained, good houses must be provided and many rural houses are devoid of modern conveniences.

Types of Farm.

What are the merits of different types of farms? How much capital is required to finance them? And what returns may be expected? These are difficult questions to answer briefly and concisely. A very long report would be required to deal adequately with the finances of any farm, and as pointed out on page 7, no two are alike. But these questions are asked every day, and in response to what is a clearly defined demand, *rough estimates are given.* They must not be taken as average figures, but merely as indicating the magnitude of the finances involved. They are based on 1939 values and for what would be regarded as good average farming.

Values were about doubled by war conditions and a man entering a farm would want much more working capital to-day than in 1939. Rents of sitting tenants* were not raised, but when farms change hands it is possible to get up to 50 per cent. more rent than could be obtained in 1939, and freehold values have increased in a similar proportion. If a man were farming for maximum production the working capital required would be increased by at least 25 per cent., while at least 25 per cent. less would suffice for a low standard of farming. Adjustment is necessary for the size of the holding, the estimates given below are for medium sized farms, slightly more working capital per acre would be required on a small farm, and slightly less on a large farm.

Farms can be divided into three groups (1) general, (2) market garden and fruit, (3) pig and poultry farms, and each group must be dealt with separately.

General Farms.

The term will be used to describe those farms upon which ordinary farm crops and stock are produced, i.e. arable, stock, mixed, dairy farms and hill farms. General farms are to be found on all classes of soil. For the purpose of this book they will be sub-divided according to size as follows:—Small holdings up to 50 acres, small farms from 50–150 acres, medium sized farms 150–500 acres, large farms over 500 acres.

An estimate of the capital required for a medium sized farm is given below; the annual rent is taken at the 1939 figure. The freehold value is the 1939 figure based on (1) the assumption that the land is free from fixed charges such as tithe and (2) the normal practice of valuers, i.e. 25 years' *purchase** of the net *annual value.** The working capital is the approximate amount that a good farmer would expect he would need on taking over a farm. It is based on the assumption that (1) non-pedigree female stock is purchased, (2) the main part of the less complicated implements and equipment are purchased second-hand, (3) there is nothing exceptional in the ingoing valuation, (4) only " ordinary " farm equipment is obtained.

Type of land	Approximate value of land		Approximate amount of working capital per acre
	Annual Rent per acre	Freehold per acre	
Very poor	10/–	£10	£10
Good average	30/–	£30	£20
Very good	£4–£5	£100	£30–£50

Market Garden and Fruit Farms.

The standard of farming employed on farms of this group is intensive, and the term " small holding " can hardly be applied here to any holding which is more than 20 acres. The term " small farm " will be applied to holdings of from 20 to 50 acres, that of " medium " sized farms to those of 50–200 acres, and " large " farms to more than 200 acres. Market gardening requires a highly fertile soil, and suitable land will make about £100 per acre if sold, and an annual rent of £4–£5 per acre, while at least £40 per acre is necessary for working capital. As regards fruit, different kinds of trees show marked preferences for certain types of soil, and cannot be successfully cultivated on many other types. Fruit cannot be grown commercially in situations where late frosts are very liable to occur. Therefore the siteing of a fruit plantation is a matter which calls for considerable experience, but under modern conditions advice of this kind is readily obtainable from the Advisory Service, a point which will be dealt with on pp. 76–78. Standard fruit trees take 5–10 years to establish themselves, and from the time of planting until the trees come into full production they will cost some £50–£100 per acre. An established orchard will sell at from £50–£100 per acre, and such orchards will make an annual rent of £3–£5 per acre; while some very good orchards will sell for £400–£500 per acre. About £25 per acre will suffice for working capital on an established orchard.

Pig and Poultry Farms.

Farming of this type can be carried out on comparatively small holdings on poor dry land. The amount of working capital required for pig farming depends upon the class of pigs kept. Land costs an insignificant amount, but buildings and/or pens will cost £15–£30 per sow. If the output is sold as weanyer pigs, a working capital of about £20 per sow will suffice—the amount rising to £30 per sow if the output is in the form of porkers, and to about £45 per sow for baconers at 1939 values. The last figure represents the minimum requirement for a herd in which the main object is the production of pedigree breeding stock.

£1,000 would be sufficient for the working capital for a commercial egg laying plant with a capacity of 1,000 birds.

Returns.

The point cannot be too strongly emphasized that the financial returns accruing from the working of a farm are very largely determined by the capacity of the farmer; his drive and energy; skill in managing labour, cultivating the soil, rearing live stock, and as a business man. These are crucial factors. No two men have the same capacity to make a farm pay. There are some who would make a substantial profit out of almost any farm, whereas under identical conditions many would only make a precarious living, and others serious losses.

Farmers generally manage their own farms and are entitled in addition to any wages they may earn by manual work to a manager's salary, which should be deducted from the returns before the profit is assessed. Opinions differ as to what constitutes a fair remuneration. I consider that the most satisfactory method is to base the amount on the system and standard of farming and suggest at least 10/– per acre per annum should be allowed for what is called a low standard of farming, £1 per acre per annum in the case of good average farming, and £2 per acre for intensive farming. Even at such rates farmers' salaries would compare unfavourably with those of managers who carry comparable responsibilities in other industries.

The great fluctuations which occur in returns from farms render it dangerous to form an opinion on results obtained over a comparatively short period, and very few farmers can produce records which show their earnings during the first forty years of this century. It is, however,

possible to obtain indirect evidence on this point from the standard of living that they have maintained, and from business men who have a large number of farmers as their customers. Such evidence indicates that if a salary on the lines suggested above were allowed, a very large number of farmers would not show an average profit (over the forty years) of 3 per cent. on working capital.

Another fact which must always be remembered is that the returns are at the mercy of the weather. No profit, and often a serious loss, is likely to accrue in years in which adverse weather conditions prevail, and weather is liable to occur in cycles, two or three bad years being frequently experienced in succession. Thus the farmer must be prepared to live for two or three years on his earnings and in some years to forego a very large part of them in order to avoid financial disaster.

What then can different types of farmers expect to earn? Both small holders and small farmers generally do as much work as any paid worker and earn a full labourer's wage, and to this their salary as a manager should be added. On the basis suggested above, this would mean that a small farmer on a general farm of 50 acres, or a market garden [illegible] of 25 acres would earn a labourer's wage [illegible] £50 a year as manager. The same applies to [illegible]any, but not all, of those who farm medium sized farms. In this case much depends upon the standard of farming. Those who farm medium sized farms intensively are usually fully occupied with managerial work and have little or no time to do manual labour. These last will obviously only earn their salary as manager. This also applies to those who farm large farms.

While considering the returns from farming there is a point which should be borne in mind. It is that on small holdings, small farms, and medium sized farms which are not large enough to justify a working foreman, there is little or no respite for the farmer—he frequently must work 52 weeks in the year, and on the smaller stock farm oftimes works seven days a week for a considerable portion of the year.

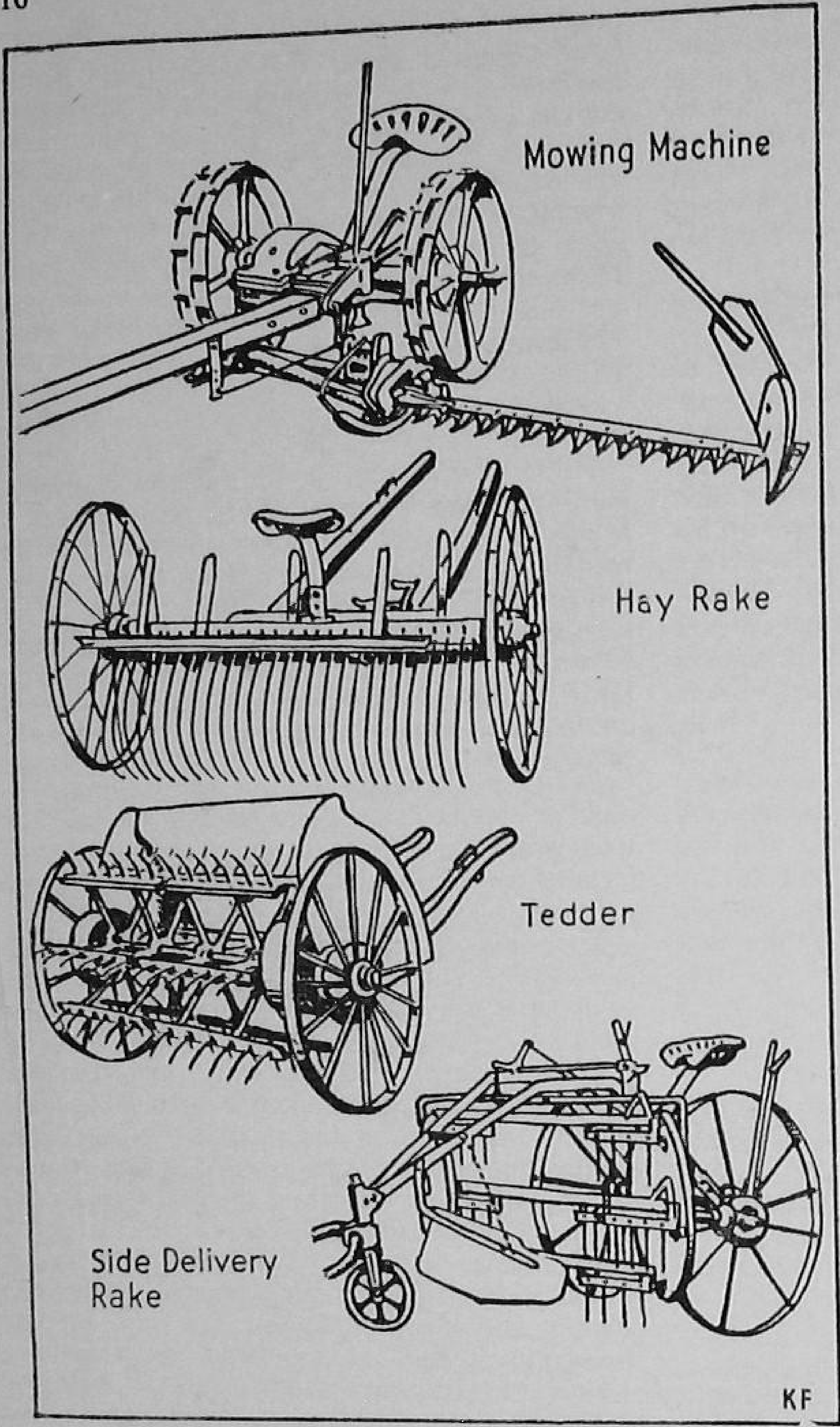


FIG. 9

FARM MACHINERY

In Section IV of this volume pp. 222–278, the subject of "Good Farming by Machine" is discussed, but here in his general survey our present author contributes some preliminary notes on farm machinery:—Benefits accruing from machinery. Economic limits. Some useful machines. Machines in use on a 500 acre farm and on a 60 acre mixed market-garden and fruit-farm.

Benefits Accruing from the use of Machinery.

BETWEEN 1939 and 1943 the number of farm tractors rose from 50,000 to 120,000, and there was a similar increase in other machines. The sue of this additional machinery made it possible to increase output in spite of the labour shortage created by the withdrawal of a large number of men for the fighting services. It also rendered possible the increase in the wages of farm workers and the improvement of their working conditions. Benefits which, but for the increased mechanization of the industry, could only have been obtained by a prohibitive rise in prices.

Then again in certain directions the use of machinery increases efficiency. The most outstanding example of this occurs in connection with the cultivation of land; for owing to the changeable nature of the weather of this country, speed is oft-times essential to success, because frequently there are only short periods during which the conditions are suitable for preparing seed beds and sowing seeds. This means that the ability to perform such operations quickly makes all the difference between success and failure: with tractor drawn implements it is possible to cover at least three times as much ground each day, even on the heavier jobs, as was possible with the horse-drawn implements they replace.

Some operations which have become routine practice of modern farms could not be carried out on a commercial scale without the aid of modern machines. Most notable of these is spraying; the simplest example is the case of an orchard of standard fruit trees, for only by the use of a power-driven spraying machine can all parts of the trees in such an orchard be covered efficiently with a spray solution.

Economic Limit.

There is, of course, a limit to the extent to which machinery can profitably be employed upon any farm, for if the amount of capital sunk in machinery becomes excessive, the depreciation thereon will eat up much of any possible profits. Therefore there are times when a farmer must restrain his desire to purchase a new machine, and there are three points which should be carefully considered before deciding to purchase. Firstly, if it is available, on how many days in a year will the new machine be used? For obviously a new machine should not be acquired unless it can be used sufficiently to enable it to make a fair return on the cost. Secondly, many modern machines must be housed, and unless suitable accommodation is available it can only be provided by additional expenditure on buildings.

Thirdly, a labour-saving machine is not justified if it displaces *available* labour unless a profitable use can be made of that labour.

Here is an example which illustrates two of these points—A dairy farm in 1939 consisted of 200 acres of land of which 20 acres were arable and the remainder were permanent pasture. A herd of 45 dairy cows was kept; all the heifer calves were reared, and those not required for the herd sold in-calf. There was a team of two horses and a single horse. The staff consisted of four men who could all milk, and one woman who came in to assist with the milking.

Then neither a tractor nor a milking machine could be justified because, if available, the labour they would displace could not be profitably utilized, and during the summer months, even with these machines, the staff could not be reduced. The problem, however, was entirely altered when the farmer was called upon to plough up 100 acres of the grass land. A rough standard generally accepted is that one team of horses is required for each 40 acres of arable land, and a light tractor is equivalent to two teams of horses. So a tractor and one team could cultivate the 120 acres of arable land. A milking machine enabled the cowman and the woman, with occasional help, to manage the cowshed. This left three men for the outside work, which, with the equipment enumerated above, was sufficient under war conditions.

Many of the implements used in the cultivation of the soil can be hired, so that even small-holders are able to obtain the machinery necessary to cultivate the land efficiently. The cost of hired implements may at times seem to be high but it is almost invariably true that a larger profit will accrue from, or a smaller loss be incurred in respect of, a well cultivated crop than one grown after inefficient cultivations, however cheap the latter may be.

Some Useful Machines.

Barn machinery calls for but little comment. A service of power is usually desirable. If a supply of cheap electricity is not laid on to the farm buildings, the necessary power is usually obtained from a small oil-engine. Electric light is a great asset to a homestead; it saves labour and increases efficiency. Before the war the number of electric light plants installed on outlying farms was increasing rapidly. The total number of farms with electricity installed was approaching 50,000.

A milking machine is part of the equipment of a large number of dairy farms and the number grows steadily. There was a time when a justifiable prejudice existed against these machines, but many of the defects of early models have been rectified, and although each plant has its " little peculiarities " the present day models are efficient. Three points must be observed punctiliously on farms producing milk. The first is reasonable precautions to keep disease-producing organisms from getting into the milk; the second is cleanliness, and the third is efficient cooling. A sterilizing plant for cleansing dairy utensils is part of the equipment of a modern dairy farm. Cold water is necessary to ensure efficient cooling, and many up-to-date dairy farms have a refrigerator to cool the water used in the cooler.

Horses are still to be found on most farms, although they are being rapidly replaced by motors. A small minority of farmers claim that horses can be dispensed with altogether, but the majority consider that greater elasticity can be obtained from a combination of horse-drawn and mechanically operated implements. Twenty years ago tractor-ploughing compared unfavourably with the work done by the horse-plough; but in recent years tractor ploughs have been improved out of all recognition, and in the hands of a skilled man they do work which compares favourably with the best horse-ploughing. The introduction of rubber tyres suitable for tractor wheels has greatly increased the utility of farm tractors. Comparable improvement has been effected in the track-laying tractors from which it is now by no means uncommon for farmers to obtain 2,000 hours work without an overhaul.

The value of tractors has been greatly increased by making additional use of the power to drive a machine as well as haul it. For instance, by the use of the power take-off, a tractor will drive the cutting and tying mechanism of a binder. Previously the drive was taken from the big wheel of the binder, and if the ground was wet and cutting difficult, a slipping wheel meant many blockages. From the power take-off less power is wasted in transmission because the drive is more positive.

Practically all tractors can be used as stationary engines, and if machines such as root-pulper, corn-grinding mill or saw-bench provide an economic load this additional use is particularly helpful in reducing overhead charges and depreciation. The tractor can be used to drive a small threshing machine on farms which are large enough to justify such a machine.

The row-crop tractor which, by reason of its variable track widths and good ground clearance, can work in between the rows of crops like potatoes or roots has opened up another field. There is a variety of tool-bars for use with a row-crop by which tractor and implement become virtually one unit. A variety of tools such as different hoe-blades, discs, ridging bodies, potato-lifting bodies, harrow and fertilizer distributing units are interchangeable on the tool-bar and make the machine virtually the equivalent of a range of implements. Some tool-bars can be put down to, and lifted out of, work by the operator from the tractor seat. They may be mounted either in front, amidships (under

by a number of the larger growers.

The combine-harvester is another machine which has been introduced to many farms within recent years. This machine, which cuts the corn just below the ear and leaves most of the straw in the field, also threshes the grain and delivers it into sacks. The water-content of the grain of corn grown in this country in most seasons is too high to permit it to be stored for any length of time or milled if threshed straight from the field; but it can be stored indefinitely or milled if it is dried. Grain driers are now a commercial proposition, and one of them must be available for use with a combine-harvester. To meet war conditions the Ministry of Food arranged for driers at strategic points to supplement those already on farms. It should be added that many of those who have used these machines speak very highly of them.

In our changeable climate it is necessary to collect hay as rapidly as possible once it has been " made ". If it is desired to cart the hay away from the field in which it has been grown, the work can be expedited by using the hay-loader to pick up the hay and convey it onto the wagons; but the quickest method of dealing with the hay crop is to collect it with hay sweeps—a method that has become very popular in recent years, though it necessitates ricks being built in the fields in which crops are grown.

In addition reference may be made to the following implements which have gained popularity since the outbreak of the last war.

The need for grinding home grown corn for stock food has drawn attention to the merits of the hammer-mill, a machine in which blockages are reduced to a minimum.

For some years before the war the pitch pole harrow was gaining the reputation of being superior to the ordinary drag harrow because it gives positive and adjustable penetration, and also because of the ease with which it can be freed from weeds and rubbish.

Sugar-beet lifting machines have become increasingly popular since the sugar-beet acreage has expanded. Also a machine of Danish origin, now manufactured in England, which will lift and top swedes, has been taken up by a number of growers. A light compact machine which cross blocks sugar-beet has gained popularity partly because of the fact that it economizes

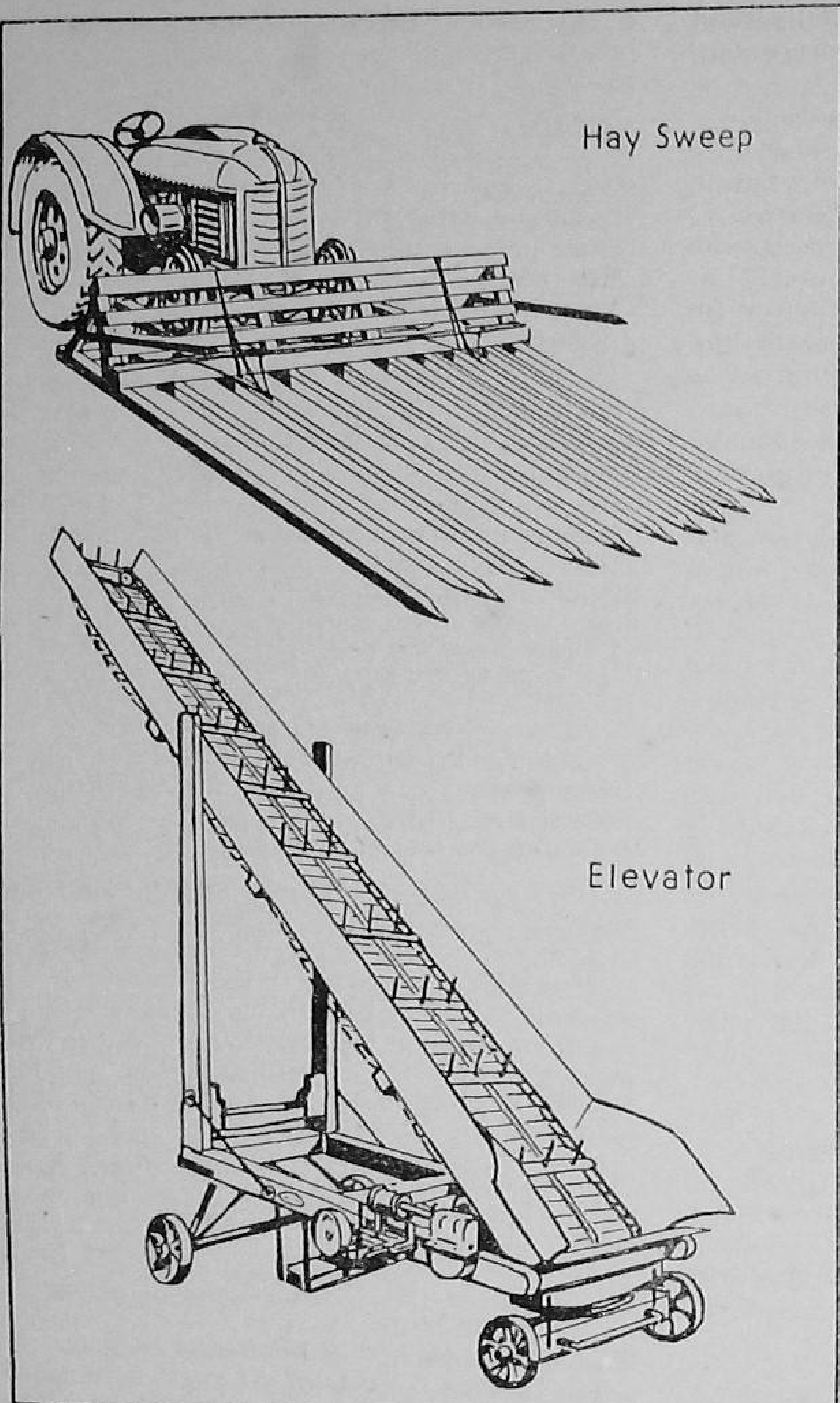


Fig. 10

the engine) or behind the tractor. The last is the position most frequently selected, but there are advantages and disadvantages peculiar to each position.

Rotary cultivators, which break up the soil by means of revolving tines have been developed during the past fifteen years. Small machines of this type are now employed on many market-garden and fruit holdings. The Gyrotiller, a large model suitable for general farm use came on the market some little time before the war. I consider this is one of the machines of the future, although it has not yet attained any very great popularity amongst farmers. It has, however, proved very useful in land reclamation.

A machine for planting plants such as cabbages has been recently perfected and is now used

labour in singling, and partly because of the speed with which it works. This means that even with the minimum amount of labour the crop can be thinned while the plants are at the best stage, i.e. when they are easiest to deal with and when they recover comparatively quickly from the operation.

The American peg drum has been found useful because with it the number of workers required for threshing can be considerably reduced. At the same time a slightly higher output is obtained compared with the normal type of thresher: but the peg drum has the disadvantage that the straw it threshes is not suitable for thatching.

Interest has been revived in the elevator type of potato lifter, a machine which can be adapted to deliver the tubers into bags or baskets.

Bull dozers have proved their value in land reclamation. These are track-laying tractors fitted so that they push large amounts of earth before them (or, in the case of angle dozers, to one side). They are used for levelling land irregularities and also for pushing out tree stumps or saplings from felled woodland.

Two Examples.

The extent to which machinery is employed can best be demonstrated by actual examples, and appended will be found a list of the machines in use in 1943 on (*a*) a 500 acre mixed diary farm, (*b*) a 60 acre market garden and fruit holding. Both were well equipped, but in neither case was an excessive amount of machinery employed. The figure for the cost is the 1939 catalogue price of the machines.

Machinery on 500 Acre Mixed Dairy Farm.

The farm selected has a free working soil and consists of 80 acres of permanent pasture, and 420 acres of arable land. The latter includes 120 acres of temporary leys (the leys on this farm are left down for three years). The implements in use in March, 1943, were:—

Tractor and Tractor Implements

	1939 price £	s.	d.
1 Tractor. (International 10/20), fitted with rubber tyres	300	0	0
1 Row-crop tractor with equipment	240	0	0
2 Tractor ploughs, complete with press—			
2-furrow plough	33	10	0
3-furrow plough	47	0	0
Press only	17	10	0
2 Cultivators	21	0	0
1 Disc harrow	42	0	0
1 Ring Roller (3 Sections)	17	10	0
1 Spraying machine for potatoes (5-row)	31	10	0
1 Potato lifter (digger)	26	5	0
Carried forward	776	5	0

Tractor and Tractor Implements—(*contd.*)

	£	s.	d.
Brought forward	776	5	0
1 Combined seed and manure drill, adjustable to sow roots (Massey 13-row disc)	48	10	0
1 Mowing machine (6 ft. cut.)	29	10	0
1 Swath turner	23	10	0
2 Hay sweeps, No. 2 Cottes for Fordson	31	0	0
2 Self binders (6 ft. cut, driven from power take off)	134	0	0
1 Threshing machine	430	0	0
1 Straw trusser	70	0	0
2 Sets light harrows	12	7	0
1 Pitch-pole harrow	26	10	0
1 Elevator	67	10	0
1 Portable engine	17	10	0
1 Shearing machine (2 brackets)	32	10	0
2 Horse ploughs (balance)	34	0	0
1 Potato sorter (Edlington)	21	0	0
1 Seed barrow	7	10	0
1 1-Horse-drawn hay rake	19	0	0
1 Horse-drawn tedder	29	0	0
Barn Machinery			
4½ h.p. Stationary engine	45	0	0
Grinding mill	30	0	0
Cake crusher	7	10	0
Winnowing machine	21	0	0
1 Electric light plant	say 200	0	0
1 Milking machine	150	0	0
1 Cooler	4	8	0
1 Refrigerator for cooling water for cooler	130	0	0
1 Sterilizer	35	0	0
2 Weighing machines	20	0	0
2 Horse-drawn tip carts, fitted with pneumatic tyres	82	10	0
3 Lorries	150	0	0
1 Motor lorry	300	0	0
	£2,985	0	0

Machinery on 60 Acre Horticultural Holding.

This holding consists of 40 acres of standard fruit, and 20 acres of market-garden crops. The machinery in use in March, 1943, was as follows:—

	£	s.	d.
1 Row-crop tractor, complete with tool bar equipment	250	0	0
1 Spraying outfit	95	0	0
Horse-drawn			
2 Shims	11	0	0
1 Set harrows	4	10	0
1 Planet Junior seed drill	3	15	0
1 Tip cart	27	10	0
1 Van	300	0	0
	£691	15	0

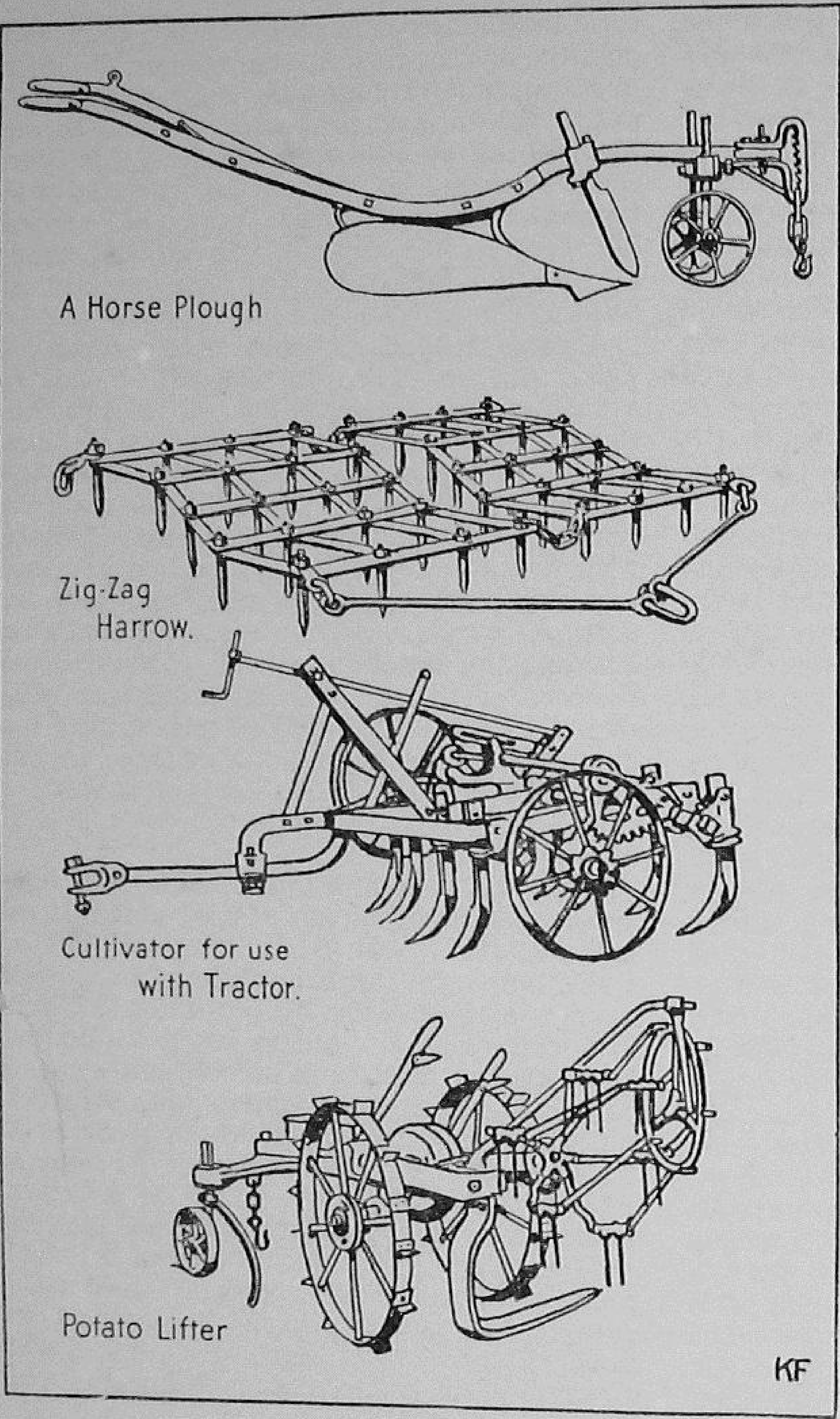


FIG. 11

FARM CROPS

A subject which will receive full attention in Section III of this volume pages 149 to 219 is here briefly reviewed. A summary is now given of some of the most important features in the cultivation of the crops generally grown on commercial farms—Soil cultivation: objects, use of weathering, production of tilth —The destruction of weeds—Manuring: farm yard manure, lime, artificial manures, general principles—Seed, importance of purity, choice of variety—The Principal Farm Crops: the white straw crops, forage crops; sugar beet, potatoes; pastures: permanent, leys—Market garden crops and fruit.

THE foundation of success in crop husbandry is efficient cultivation of the soil, but if the best results are to be obtained this must be combined with economical manuring and the use of good seed. Money expended on seed is likely to be wasted unless the seed bed in which it is sown has been properly prepared, and heavy manuring will not compensate for imperfect cultivation.

Soil Cultivation.

The objects of cultivation are: (*a*) to cause the soil to break down and to allow air and water to circulate through it; (*b*) to mix manure intimately with the soil; (*c*) ultimately to produce a tilth* suited to the crop the land is to carry; (*d*) to destroy weeds. The most potent factor in cultivation is weathering.* Not only can it reduce hard clods that defy the most powerful implements but weathering produces a desirable condition known as a "mellow tilth," whereas the tilth produced mechanically, that is by working dry soil repeatedly with cultivator, harrows and roller, is described is "harsh" and is less desirable. Not all the soil conditions produced by weathering are helpful to the farmer even though their ultimate effect may have a beneficial influence on its mechanical condition.* For example, soil which is frozen is so hard that nothing can be done to it, but immediately such soil has thawed it breaks down readily if stirred. Then again very wet soil is frequently sticky and will not break down if tilled and seldom will very dry soil, the latter usually being too hard. But the alternate wetting and drying has a beneficial effect upon the mechanical condition* of the soil, and when soil that has been very wet dries, or soil that has been very dry is moistened, they eventually arrive at a workable condition, i.e. a condition in which they break down readily if tilled.

Recognizing these facts the skilful cultivator arranges his operations so as to make the best use of the weather. In the first stage his object is to break the soil and leave it in a condition that will enable the weather to have the maximum effect upon it. Generally this first step is effected by ploughing, an operation which breaks the soil and allows air and water to penetrate into it and at the same time leaves it in furrows* with a maximum surface exposed. No subsequent

operation will correct the ill effects of a bad first ploughing. It is therefore essential that this operation should be done efficiently—on many soils it is not advisable to plough too deep, but very shallow ploughing is also undesirable. All the surface soil should be cut up to a uniform depth and the furrows properly turned. If this initial ploughing is done with a tractor the machine should be driven slowly, for if the work is done at too high a speed *all* the furrows will not be efficiently turned. When the exposed surface has been " weathered " the soil is stirred to expose fresh surfaces. This stirring may be done with the plough but more frequently it is carried out with the cultivator. Finally, as the time of planting draws near, the farmer attempts to form a tilth. This work is best performed when the soil is in a " workable " condition and it is necessary to keep a constant watch on the soil because in many seasons the occasions on which it is in a workable condition are few and far between. If a suitable opportunity does occur, the work should be pushed on as quickly as possible so that it may be completed before the soil becomes too wet or too dry. Of course in some cases the soil does not get into a workable condition at all and has to be reduced to a tilth by mechanical means, but this is always an expensive business and the resulting tilth is invariably of inferior quality. The cultivator, disc harrow, and zig-zag harrow are the implements most often used in preparing a tilth, but in the spring and summer there are times when the roller must also be employed, either to help in reduction of clods or to consolidate the soil.

The effect of weathering is cumulative. For instance when land is fallowed* for several months, during which it is cultivated at intervals, the mechanical condition of the soil gradually improves and the cumulative benefit may be sufficiently great to influence the condition of the soil for several years. The outstanding example of this is land cropped with roots or potatoes. On the other hand when land is worked down and sown within a few days of being ploughed, it only derives a small amount of benefit from weathering. If treated in this way for several years in succession the mechanical condition deteriorates to a noticeable extent. This can be seen in land upon which winter corn is grown for several years in succession.

The Destruction of Weeds.

A cultivated plant and a weed cannot occupy the same ground. Therefore the most effective method of keeping weeds in check is to grow full crops. None the less even on well-farmed land a continuous war must be waged against weeds, for the conditions suitable for the growth of crops also favour that of weeds, and weeds if allowed to flourish will deprive crops of both food and living space, while if allowed to seed they will sow trouble for the future. The best opportunity for attacking weeds is afforded when roots and potatoes are grown. A large number of weeds is destroyed both during the cultivating carried out to prepare land for such crops, and during the final cultivation; twitch or docks, if present, can be worked to the surface, collected and burned. Finally, hoeing can be carried out between the rows of the growing crop, an operation which destroys large numbers of weed seedlings.

Another method by which large numbers of weeds can be destroyed, where a tractor is available, is that generally referred to as stubble cleaning. This consists of going over all corn stubbles with the tractor drawing either the cultivator or the disc harrows. The discs should not be used on land infested with twitch because when this weed is cut up, each portion gives rise to a new plant. A large number of weeds are destroyed by the cultivation and at the same time a certain amount of fine mould is formed. The presence of this fine mould encourages large numbers of weed seeds to germinate after the autumn rains and these weed seedlings are cut up and buried when the stubble is ploughed.

Manuring.

While the value of artificial fertilizers is fully appreciated by the farmers of this country, farmyard manure (F.Y.M.) is still the main stay of arable farming. This is only right for although it is possible by judicious use of artificial fertilizers to dispense with F.Y.M. the latter is a normal by-product on most farms and obviously should be utilized. During the summer when the stock is out at grass, excreta go straight on to the land. In the winter a large proportion of the cattle is confined to the homesteads and F.Y.M. is formed from excreta and bedding. Different samples vary considerably in composition, but a ton of good F.Y.M. will contain approximately as much nitrogen as $\frac{3}{4}$ cwt. of sulphate of ammonia, as much phosphoric acid as 1 cwt. of high grade superphosphate, and as much potash as 14 lb. of sulphate of potash.

The most valuable constituents of F.Y.M. are soluble in water and care should be taken to prevent them from being lost. F.Y.M. is bulky material—a ton of this manure contains about 15 cwt. of water—a fact which makes it expensive to handle.

Next in importance as soil fertilizers are the leguminous plants: beans, peas, vetches, lucerne and sainfoin on arable land, and the clovers in pastures. Within nodules upon their roots there live bacteria which extract nitrogen from the air, and this is left to increase the reserves of nitrogen in the soil when the plants die. The cultivation of leguminous plants is the cheapest of all the methods of maintaining soil fertility.

Lime is not strictly speaking a fertilizer, none the less it is of considerable importance to the cultivator because it neutralizes acids that are

constantly being formed in the soil. Soluble nitrogen compounds, which the roots of plants can absorb contribute greatly to the fertility of the soil, and these are the product of soil bacteria. Some of these produce acids which if allowed to accumulate would inhibit bacterial action. Free lime if present will neutralize these acids as they are formed, hence its importance as a soil constituent. As lime is constantly being removed, periodic dressings are necessary on a large number of soils.

A wide range of artificial fertilizers is normally found on the market. These fertilizers include both straight manures which supply only nitrogen, phosphoric acid or potash, and compound manures which have been mixed to act as complete fertilizers for special crops.

F.Y.M. is rarely sold off a farm, and on a well-equipped holding large quantities of it are made every year. On some farms it is the only manure used, but upon the majority it is supplemented by small amounts of artificials. If a farm has no buildings F.Y.M. cannot be produced, and unless town dung is purchased the farmer must rely entirely upon artificials. Even where F.Y.M. is the only manure used, if all the hay, straw and roots grown are used on the farm, a comparatively high state of fertility can be maintained. But the best results are invariably attained from a combination of F.Y.M. and artificial manures. The quantities of artificials are frequently based on empirical standards; but a good indication, regarding the optimum amounts of phosphates, potash and lime for the production of different crops, can be obtained from a chemical analysis of the soil, and many farmers now have periodic analyses made. Such analyses can be made free of charge by the Provincial Advisory Chemist see p. 76.

Some crops respond to large dressings of manure, while others do better on residues left by manures applied to a previous crop, so it is not necessary to manure every crop every year. Better results are obtained by following a definite scheme of manuring such as the following, which shows the treatment of a 16-acre field farmed on a seven course rotation:—

Year.	Crop	Manuring per acre.
1944	Seeds (3rd Year)	No manure.
1945	3 acres Mangels 1 acre Kale 6 acres Potatoes	16 loads F.Y.M. 2 cwt. sulphate of ammonia. 2 cwt. sulphate of potash. 4 cwt. 30% super-phosphate.
	6 acres Grey Peas	2 cwt. 30% potash salts. 4 cwt. 30% super-phosphate.
1946	16 acres Wheat	No manure.
1947	16 acres Barley	½–1 cwt. sulphate of ammonia. 3 cwt. superphosphate.
1948	16 acres Barley seeded with 3 year ley.	½–1 cwt. sulphate of ammonia. 2 cwt. 30% potash salts. 3 cwt. 30% super-phosphate.
1949	1st Year Grass	No Manure.
1950	2nd Year Grass	No Manure.
1951	3rd Year Grass	No Manure.

1952–1959 Cropping and Manuring as in years 1944–1951, and so on.

Good Seed.

It is essential that good seed should be sown, and here, two points should be remembered: first the seed must be a good sample of its kind; and secondly, the best variety should be grown.

As regards the seed itself, the most valuable qualities of seed are hereditary, and seed should therefore only be saved from a good crop. It deteriorates with storage and as a rule should be sown in the season following that in which it is harvested. The vigour of seed is impaired if it is exposed to bad weather during harvest, or allowed to heat in the rick; such seed is usually discoloured. Seed from plants which have been attacked by insects or other pests or disease should only be used if it is known that the seed itself is free from disease, that it has not been damaged, and that it does not contain eggs, larvæ, spores, etc., which cannot be destroyed or removed before sowing, and may develop after the seed has been sown.

Then again seed of farm crops should be free from the seed of noxious weeds. The presence of even a small percentage of injurious weed seeds should not be ignored, as with small seeds 1 per cent by weight may represent many thousands of plants: for instance, there are approximately 3,000 dock seeds per lb.—1 per cent of dock in a sample of seed wheat would mean sowing one dock seed per square yard.

So important is good seed that the Seeds Act, 1920, and the Seeds Regulations, 1921, were designed to protect the farmer from unknowingly purchasing seeds of low vitality or those contaminated with seeds of noxious weeds. It is laid down that a guarantee of purity and germination percentage must be given when seeds are sold, and it is a punishable offence to sell for sowing, or knowingly to sow seeds containing more than 5 per cent of docks, sorrels, crane-bills, wild carrot, Yorkshire fog, or soft brome.

The view is strongly held by many farmers that an occasional change of seed is beneficial. This is a point which does not crop up in connection with small seeds which are usually purchased annually. As far as potatoes are concerned, the value of a change of seed has long been recognized —and in England many good growers procure fresh seed from Scotland each year. The question has not been so fully investigated in the case of cereals, but in their case constant change of seed does not appear to be essential. Such evidence as exists appears to indicate that there is little if any deterioration in corn grown on a farm for

seven or eight years, so long as due care is taken each year in harvesting, storing, threshing and dressing the seed.

In addition to obtaining good seed it is necessary to select the most suitable variety. The National Institute of Agricultural Botany has carried out a large number of variety trials at centres scattered widely over the country, and farmers are wise to be guided by the latest report of the Institute as to the varieties they grow.

The Principal Farm Crops

It is the object of this book to give a description of commercial farming in this country, therefore in this section, only those crops will be dealt with which occupy an appreciable area on a reasonable number of farms. Small areas of many other crops are grown but they are not of general interest.

The Grain Crops.

From very early times, wheat, barley and oats have produced a large proportion of the food of man and his domestic animals. In this country wheat is the staple bread corn, and in addition, in normal times a considerable quantity is required for poultry food. A portion of the barley is used for brewing and distilling; grain suitable for these purposes makes a comparatively high price; the remainder of the crop is ground into meal for stock. A small amount of oats is required for human consumption, the major portion of the crop being used as stock food. A small quantity of wheat and barley straw is required for special purposes, but the greater part is used as litter. A considerable portion of the oat straw is used as fodder, the remainder as litter. Strength is the character of straw that has the greatest importance to farmers. On good land it is necessary to grow varieties that have straw strong enough to stand up under a heavy crop of grain, for laid crops are expensive to harvest, and contain an unduly high proportion of small (tail) corn. The two leguminous* grain crops, beans and peas are grown entirely for stock food; they must be regarded as being of considerable importance in spite of the small area devoted to them, because they are the only home-grown concentrates with a high protein content.

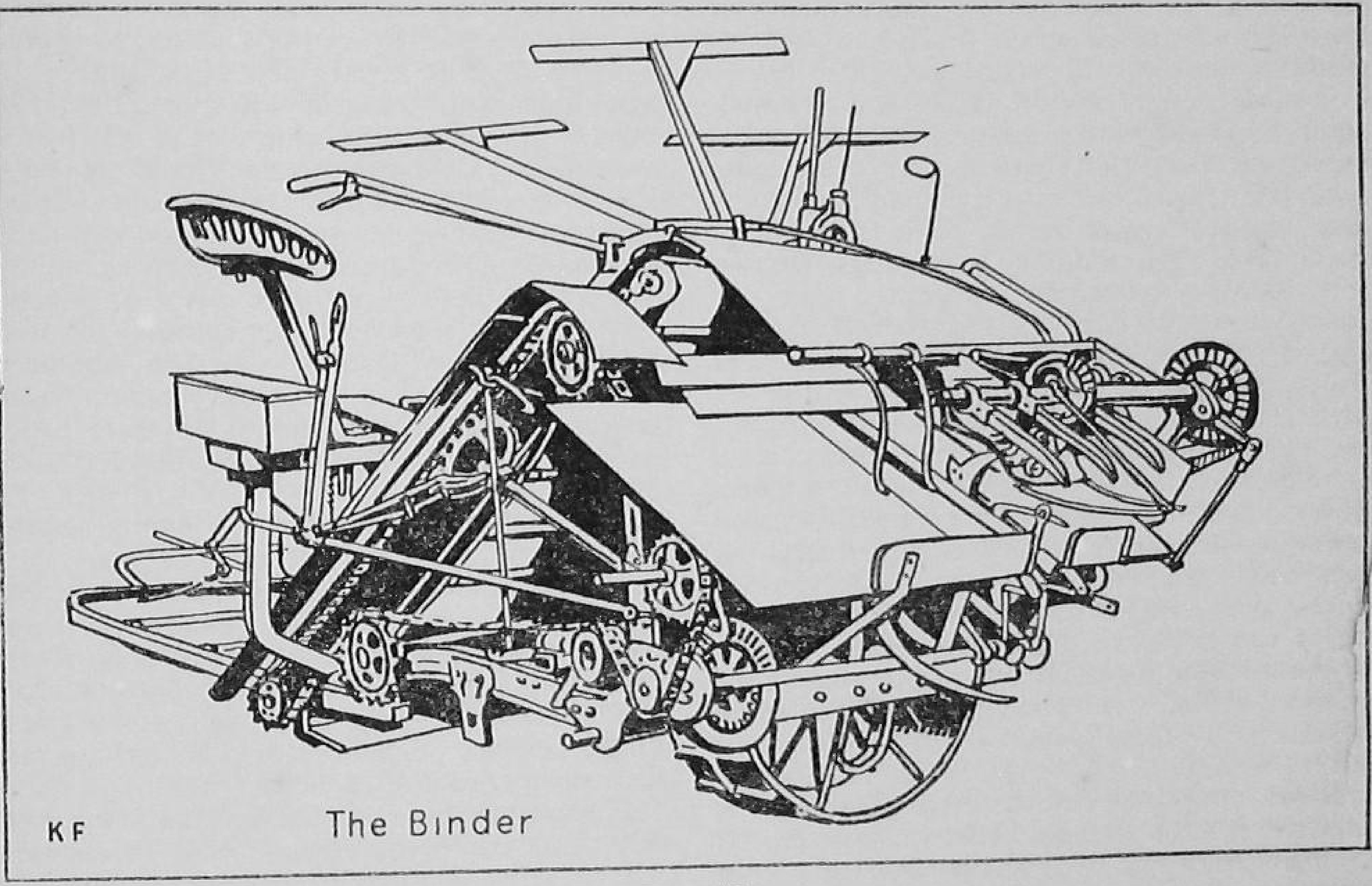


Fig. 12

If the rotation detailed on page 22 is adopted over the whole farm each year, the arable land will be divided as follows:—$\frac{3}{7}$ temporary pasture, $\frac{1}{7}$ potatoes, forage or leguminous crops, $\frac{3}{7}$ white straw crops; the proportion of wheat, barley and oats grown varies according to the district and type of land. The case cited is a very typical scheme of cropping for a general farm, and upon such holdings it is quite common to have about half the arable land under white straw crops; they produce the major part of the saleable produce from the arable land, and it is their price which determines whether or not arable farming is an economic proposition on a general farm.

Quality is very important in the case of wheat. When it is milled the grain is broken up and separated into three portions: (i) the starchy

portion, which is ground to form white flour; (ii) the germ, which is made into wheat germ flour; (iii) the skin, with a small amount of flour adhering to it, is broken up into fragments of different sizes and sorted into bran and weatings (formerly known as middlings, sharps, or pollards) which are used as foods for farm animals. The British public prefers "light" loaves, hence the importance of wheat which produces flour that will rise well. The capacity of flour to rise is determined by what is known as "its strength," and wheat, from which flour can be produced that will rise well, is known as strong wheat. The characters which determine the strength of wheat are inherited, and strength is a characteristic of some varieties. The Home Grown Wheat Committee of the British Millers' Association drew up the following table which gives an idea of the comparative strength of different varieties of wheat:—

No. 1 Manitoban	100
Yeoman (British)	90
Ghirka (Russian)	85
River Plate (Argentine)	80
All Common English wheats, such as Victor Red, Standard, Browick, Square Head Master	65
English Rivets	20

The grain of the common English wheats is slightly bolder and larger than that of the strong wheats, and for that reason the former are preferable as poultry food.

To qualify for the higher price that is invariably paid for a malting sample, barley must consist of grains of uniform size, having a thin wrinkled skin and a uniform colour. Skilful cultivation is necessary to produce barley with these characteristics, and it can only be grown on suitable soils. As far as oats, beans and peas are concerned, a high yield is the main consideration, but they should be hard enough to grind.

Wheat can be sown either in the autumn or in the spring, but in this country it is generally sown between October and December. There are some varieties of barley suitable for autumn sowing, but the greater part of the barley crop is sown between February and April. In the south of England both winter and spring varieties of oats are grown; in the north of England and Scotland only spring varieties are cultivated. Of beans there are varieties suitable for both autumn and spring sowing, but the winter varieties are only grown in the milder parts of the country. Peas are sown in the spring.

A light dressing of F.Y.M. is occasionally applied to land in preparation for wheat and oats, but this must be regarded as exceptional. The white straw crops are most frequently grown after a fallow, a fallow crop* or a leguminous crop. In such cases they do not as a rule receive any manure, although a top dressing of a quick acting nitrogenous fertilizer in the spring for winter sown wheat or oats is usually profitable. If two white straw crops are grown in succession it is usual to manure the second with nitrogen and phosphates; if three white straw crops are grown in succession it is usual in addition to give a complete dressing of artificial manures to the third crop. Phosphates and potash are frequently applied to land in preparation for beans and peas: sometimes a light dressing of F.Y.M. is given for beans, but this manure is not used for peas. As regards quantities, many good farmers would use dressings similar to those detailed on page 22.

For autumn sown crops a coarse tilth is generally considered to be desirable, and a comparatively small amount of cultivation will usually suffice to produce the seed bed. The ease and success with which this is performed depends in a very large measure upon getting the work done early; for if the land is ploughed soon after harvest and allowed a short period of weathering, it will, under favourable conditions, break down readily if stirred with a cultivator and harrows. If the work of preparing the seed bed is left until late in the autumn the same operations will be required, but by that time the soil will almost invariably have become too wet to work well, and although it will be possible to obtain a seed bed the operations will then usually have to be performed under most unfavourable conditions.

The ideal method of preparing a spring-corn seed-bed is to plough in the early autumn and leave the land in the furrow* to weather until the New Year. Then a careful watch is kept for favourable conditions—a frost or a short spell of dry weather which reduces the top two or three inches of soil to a friable condition. When such an opportunity occurs the disc harrow is put in to form a tilth to be followed by harrows and drill, and the result will be a fine mellow tilth of uniform depth lying on a firm bottom. Such a tilth can only be obtained under favourable conditions, but on light land these do occur soon or later in most seasons. Upon this type of soil a skilful cultivator who is prepared to bide his time can almost invariably produce, from land ploughed in the autumn, a first class spring-corn seed bed. Upon the other hand on heavier land favourable conditions only occur occasionally, and the cultivator has to be content in many years to do his spring work when the land is either rather too wet or rather too dry. It is rarely possible to form a seed bed of uniform depth if the work is done when the soil is too wet, and in that case a part of the seed sown does not get properly covered. If the soil becomes too dry before being worked it breaks up into hard clods which can only be reduced by several workings with cultivator, disc harrows, zig-zag harrows and roller, and the tilth which is formed is always coarse and harsh. If the land is not ploughed

before the end of February, conditions favourable for forming a good tilth rarely occur in time to be of any use to the cultivator, and it is often necessary to be satisfied with an indifferent tilth.

The seed is usually drilled and covered by harrowing behind the drill with light harrows. The amount of seed sown depends upon the time of sowing and the condition of the seed bed. Other things being equal, a comparatively small quantity of seed can be used if it is sown early, while a comparatively large quantity is required for late sowing. As regards the seed bed a comparatively small quantity will suffice for sowing in an ideal seed bed but a comparatively large quantity is required in a bad tilth. Thus for early sowing if the seed bed is ideal the minimum quantity will suffice, and for late sowing in a bad tilth the maximum quantity of seed is required. The amount of seed sown per acre is wheat and barley 2–4 bushels, oats 3–6 bushels, beans and peas 3–4 bushels. The seed of wheat, barley and oats is usually dressed with a fungicide to protect the young plants from fungi which are liable to attack them in the seeding stage. In the spring when the crops are about three inches high they are rolled and harrowed. Subsequently docks and thistles are spudded in winter wheat, barley and oats, and peas and beans are hoed.

The grain crops ripen in late July, August or early September. Peas are generally cut with a mower (figure 9), the cut crop being formed into wads.* Wheat, barley, oats and beans are usually cut with a binder (figure 12), and the sheaves stooked.* Wheat is usually cut just before it gets dead ripe, that is to say, while the straw is slightly green. It must be allowed to become dead ripe before it is carted, and usually takes about three weeks to ripen in the stooks. When it has ripened and any green material in the sheaves has wilted, the operation of carting need not be stopped by a light fall of rain.

Barley is not cut until it is dead ripe, and, providing there is no green material in the sheaves, can be carted immediately after cutting. If there is any green material in the sheaves this must be allowed to wilt before the sheaves are carted. Oats are usually cut before they are dead ripe and are allowed about three weeks in the sheaves to ensure that they are dead ripe before they are carted. Barley and oats should be dry when put in the rick. It is not advisable to cart them early in the morning when wet with dew, and the operation of carting is stopped by rain.

Peas need to be dry when carted, but beans, which are usually allowed 2–3 weeks in the stooks to get dead ripe, can subsequently be carted when slightly damp. When dead ripe the pods tend to open and shed their corn if handled when they are dry, therefore they are usually carted in the early morning when wet with dew; carting being stopped at mid-day if they then become dry.

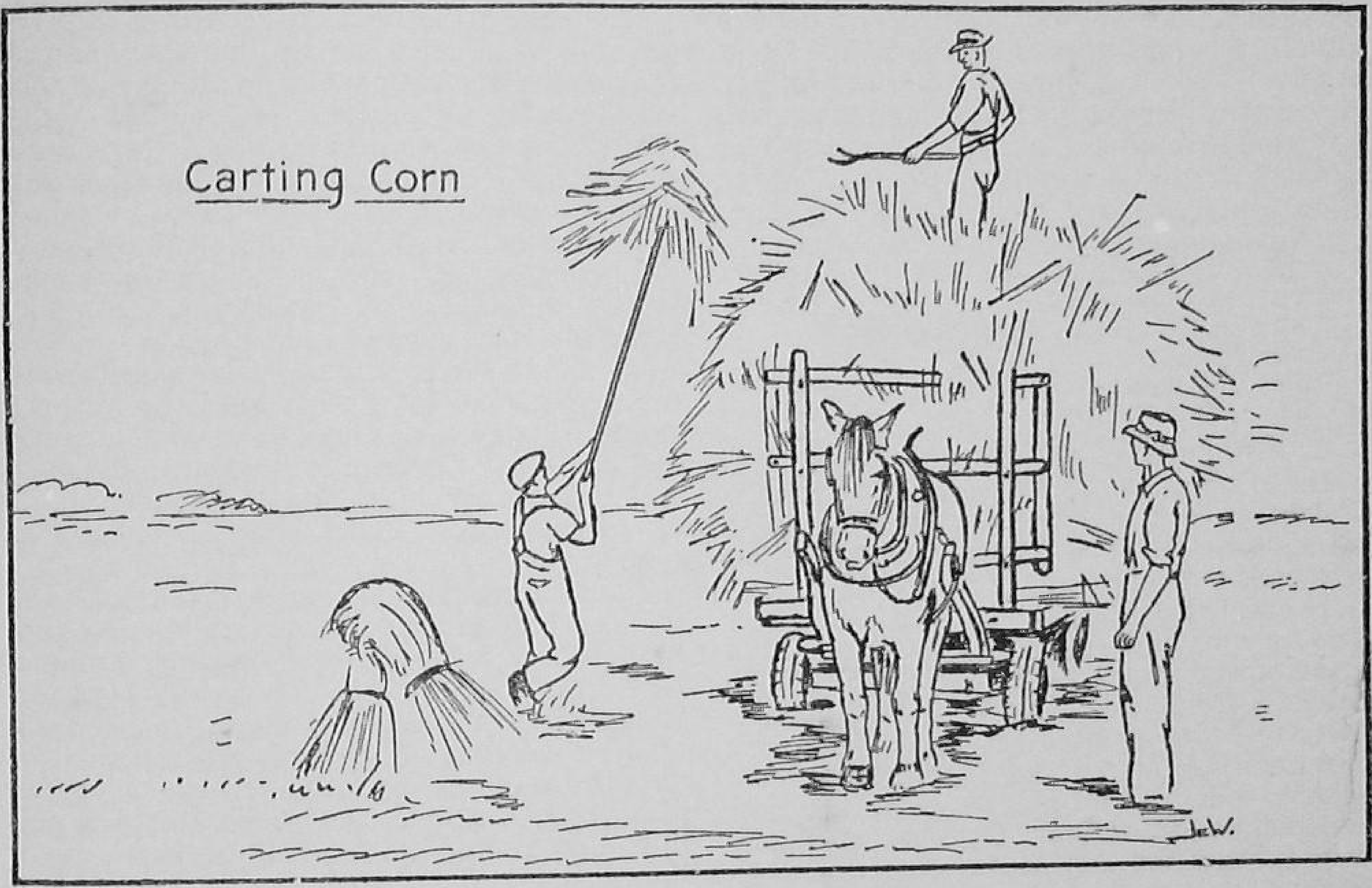


Fig. 13

Corn can be threshed as it is carted from the field or stored in ricks or Dutch barns and threshed when it is convenient. If put into a rick it must be left for a month before it is threshed. The average yield of grain is:—Wheat, barley and beans, a ton per acre; oats and peas, fifteen hundredweights per acre.

The Forage Crops.

During May, June, and July, the cattle, sheep and horses obtain the main part of their food from the pastures, but the yield of these falls drastically in August, and from the middle of October to May, a great deal of stock is hand fed. It is possible to maintain stock upon fodder and concentrates, but the cumulative experience of stock-keepers is that stock is kept in better health if such food are supplemented by forage crops, of which cabbage, kale, swedes, turnips and mangel wurzel are the most important. On some farms forage crops such as trifolium and tares are grown for use in May and June, but this must be regarded as exceptional.

A simple method is to grow cabbage or kale to provide for requirements between August and Christmas, and mangels for the period, Christmas to May. In wet districts swedes are grown to provide for the period from mid-November to March, while white and yellow turnips are grown on some farms to fill the succulent forage requirements of the early autumn. As these crops are grown for stock food their value depends upon the yield of food per acre, and that is determined partly by the yield, and partly by the dry matter content, of the crop. It frequently happens that a variety which gives a comparatively small yield with a high dry matter content produces more food per acre than does another variety which gives a higher yield with a low dry matter content. An example of this occurred in a mangel variety trial in which Golden Globe (yellow fleshed globe) gave 25 tons 16 cwt. of roots per acre, with a dry matter content of 12.7 per cent and produced 65½ cwt. of dry matter per acre; whereas Yellow Globe (white fleshed globe) gave 32 tons 4 cwt. of roots containing 9.7 per cent dry matter only, and produced only 62½ cwt. of dry matter per acre.

Cabbage seed is usually sown in a small seed bed and the plants transplanted to their permanent quarters when they are from 3–6 inches high. For use in August cabbages should be planted in February, and I have obtained excellent cabbages for use in January and February from plants transplanted in July. Kale is sown between March and August, according to the time it is required to be used. March sown plants will yield a reasonable amount of forage by August, and an August sowing will produce a small amount of spring keep. Mangels are sown in April or May, and must be lifted and pitted in October. In the south of England, June is generally regarded as being the best month for sowing swedes, but they are sometimes sown at the end of May. In Scotland, they are generally sown in May. Yellow and white turnips are sown slightly later than swedes.

Land which is being prepared for these crops usually receives a dressing of 12–16 tons per acre of F.Y.M., supplemented by suitable artificials. A complete mixture, such as the mixture given on page 22 is generally used for cabbage, kale and mangels, but only phosphates and potash are as a rule applied for swedes and turnips, such dressings as 3 cwt. superphosphate and 2 cwt. potash salts are usually applied to these crops. Frequently kale, turnips and swedes, which are to be consumed by sheep folded* on the land, are only manured with artificials; in this case mixtures similar to the following are usually applied:—1 cwt. sulphate of ammonia, 3 cwt. superphosphate, 2 cwt. potash salts; the sheep supply the soil with organic manure when they consume the crop.

As regards the time of application of manures, farm yard manure is usually applied before the land is ploughed in a dry climate, but not until the land is ready for planting in the spring in a wet district. The reason for the difference is that a dressing of F.Y.M. increases the capacity of the soil to retain moisture, and in a dry district the farmer's efforts are directed towards conserving soil moisture. Upon the other hand in a wet district everything possible must be done to encourage the soil to dry as quickly as possible in the spring, and therefore F.Y.M. is not applied in the autumn, but as the last operation just before the soil is worked down to a tilth in the spring. Artificial manures supplying phosphates and potash are usually applied either just before sowing or, with a combined seed and manure drill, at the same time as the seed is sown. Nitrogenous manures are frequently applied at the same time as phosphates and potash, but they may be sown as a top dressing.* It may be added that the practice of mixing the artificial manures together and sowing the mixture at the same time as the seed with a combined seed and manure drill is rapidly gaining popularity.

The amount of cultivation given to land which is to carry a forage crop varies with the district. The main cultivations for these crops are performed in the spring, and each time land is moved in the spring it loses moisture. Therefore, in dry districts where moisture content is usually the limiting factor, spring cultivations should be reduced to a minimum. In wet districts the reverse is the case; here the work of preparing a tilth is often held up by the fact that the land is too wet to work, and everything possible must be done to expedite the process of drying.

Land that is to be planted with forage crops is not usually touched until all the other autumn work is finished, and in consequence is not often ploughed until late in the season. It is left in the furrow to weather through the winter. The

seeds of all these crops are very small and should be sown in a seed bed that has only one or two inches of loose soil on the surface, below which the tilth should have been well consolidated. In a dry district the ideal way of forming the seed bed is to wait until the soil is beginning to dry in the spring and then work it down with a series of stirrings with cultivator, disc harrows and zig-zag harrows, each operation being shallower than the one that preceded it. The seed is invariably sown on the flat, and the work is finished by harrowing and rolling. In a wet climate the spring cultivations are usually started with the plough and as a rule the land is ploughed twice. This helps to dry the soil and at the same time breaks it down: as soon as the soil has dried sufficiently the work of forming a tilth is continued with the cultivator, harrows and roller. Often the seed is sown on the ridge, in this case after the tilth has been obtained, the land is ridged, the tops of the ridges being subsequently flattened slightly with a light roller, and then the land is ready to be drilled. These crops are grown in rows which are 2 to 3 feet apart, and the plants when 3 inches high are singled; those of mangel and turnip are left 9 to 12 inches apart, and kale 6 to 8 inches apart. Hand- and horse-hoes are used at intervals during the summer to keep the crop free from weeds.

Between 5,000–10,000 cabbage plants are required to plant an acre depending upon their distance apart. The average yield is about 20 tons per acre, but up to 40 tons per acre are sometimes grown. Kale is sown at the rate of 4–6 lb. per acre and gives an average crop of 12 tons per acre. The average rate of seeding for mangel is 6–10 lb. per acre. The average crop is 20 tons per acre, but crops of over 30 tons per acre are often obtained. Turnip seed is sown at the rate of about 3 lb. per acre, and an average crop is 15 tons per acre.

Sugar Beet.

Sugar Beet may with advantage be mentioned at this stage. It is an important crop because needing, as it does, very thorough cultivation, an improvement in the standard of arable farming almost always follows its introduction to a farm. Also, during the war the whole of the domestic sugar ration had to be obtained from home-grown sugar beet. And again it can provide large quantities of stock food in the form of beet tops and dried sugar beet pulp.

Sugar beet can be grown successfully on most well drained soils of moderate depth. It does best in a fairly dry climate, and when established is not harmed by a spell of dry weather. Manuring consists as a rule of 10 tons F.Y.M. per acre, supplemented by a complete dressing of artificials such as: 3 cwt. sulphate of ammonia, 1½–3 cwt. (30 per cent) superphosphates, 1–2 cwt. of muriate of potash, and up to 5 cwt. of agricultural salt. 15–20 lb. of seed is sown per acre in rows 18–20 inches apart, between the first week in April and mid-May. The plants are thinned to 9 inches apart in the rows. Otherwise the general principles upon which the cultivation of mangels is based apply equally well to this crop. The roots are lifted between the end of October and December and delivered straight to the factory. The average yield is 8–10 tons per acre, but up to 15 tons per acre are frequently grown.

Potatoes.

This must be regarded as an important crop, as potatoes are one of the staple foods of the people of this country. Popular varieties not only make the highest prices, but are comparatively easy to sell, so that quality is an important consideration. The consumer requires medium sized or large tubers which are good cookers, showing a preference for well shaped potatoes with a thin skin and few and shallow eyes. In addition, the farmer desires varieties which will give a large yield of saleable tubers that will not deteriorate if stored, and possesses the ability to resist disease.

In Volume III full attention will be given to pests and diseases. It must here be pointed out that the potato crop is attacked by several ailments. The most common is the disease known as "potato disease" or "blight," *Phytophthora infestans* (Mont.) De By., which spreads rapidly under humid conditions, but can be controlled by spraying. Another destructive disease is "potato wart disease," which is very infectious and spreads with alarming rapidity. There is no fungicide known which will kill the spores of this disease, nor is a remedy available if a crop is attacked; but some varieties are immune to the disease. Under the Potato Wart Disease Order, areas in which the disease has been prevalent are scheduled and in these areas only varieties immune to that disease may be planted. Leaf roll and mosaic are two virus diseases which are liable greatly to reduce the yield of any crop they attack. Carried from plant to plant by aphis, every diseased plant is a centre from which they spread, and no effective remedy is known once a plant is attacked. They are introduced in the seed, so that their incidence can be avoided by the use of seed free from infection. Seed potatoes that are infected do not show any external evidence of the fact; evidence of freedom from these diseases can only be obtained by inspecting during growth the crop from which seed is to be saved.

The importance of planting good seed is fully appreciated by potato growers. It has been found that a stock of potatoes is liable to deteriorate if grown for several years in succession in England, and most English growers import Scotch or Irish seed periodically. Some procure Scotch seed every year, a more usual practice is to plant Scotch seed every other year, or even once in three years, using home grown seed

in the interval. Class I Scotch seed is a term imposed under the Seeds Act (1920). It signifies no more than that the seed has been grown in Scotland, and in order to help growers to obtain first class seed the Department of Agriculture for Scotland which inspects all crops from which seed potatoes are to be saved, will at the request of the grower issue certain additional cerificates in respect to any crops which qualify for them. S.S. or "Stock Seed" certificates are issued for super grade crops. T.S. (A) certificates for immune varieties, and N.I. (A) for non-immune varieties—are given to growing crops which are 99.5 per cent true to type and have not more than 1 per cent of virus disease. T.S. (H) certificate for immune and N.I. (H) for non-immune varieties—are issued for similar crops which do not contain more than 3 per cent of virus disease. It is very important that seed potatoes should be protected from frost, a point which should receive attention when they are being transported.

A frost will kill the leaves of a potato plant, therefore all risk of a late frost should have passed before the young shoots come above the ground. This is the fact which determines the date of planting. In some of the early districts sprouted seed can be planted as early as the beginning of February; by far the greater part of the seed is planted in April, while in very late districts it is not safe to plant until the end of May. The seed of early varieties is sprouted before planting as is that of main crop potatoes in late districts. Between 15 cwt. and 25 cwt. according to the size of the tubers, is required to plant an acre.

The basis of the manuring of this crop is F.Y.M. of which 10–16 tons are usually applied per acre. It is supplemented by between 6–12 cwt. per acre of a complete mixture of artificial manures, such as 2 cwt. sulphate of ammonia, 2 cwt. sulphate of potash, 4 cwt. superphosphates.

Land which is to carry a potato crop always receives very thorough cultivation, and the general principles laid down for the cultivation of roots apply equally well to this crop except that potatoes are generally planted in ridges, so the last operation is to ridge the soil. The sets are placed in the furrows and covered by splitting the ridges. The cultivators are kept going as long as possible after planting. The sequence of operations followed by different growers varies greatly, but the objects are always the same, i.e. to keep down weeds and ensure the formation of a good depth of fine soil, with which the crop is ultimately "earthed up." Except in hot, dry seasons the crop should be protected from potato disease, and the most common method is to spray with Bordeaux Mixture. For main crop varieties the first spraying is generally done at the beginning of July; but in early districts it may be necessary to apply it in June, and here early varieties may need spraying at the end of May or early in June. The second spraying is usually necessary about three weeks after the first. Spraying with Bordeaux Mixture is a preventative measure, and should be carried out before the disease attacks the crop, and its efficiency is determined by the extent to which the leaves—especially the under-surfaces—are covered with the fungicide.

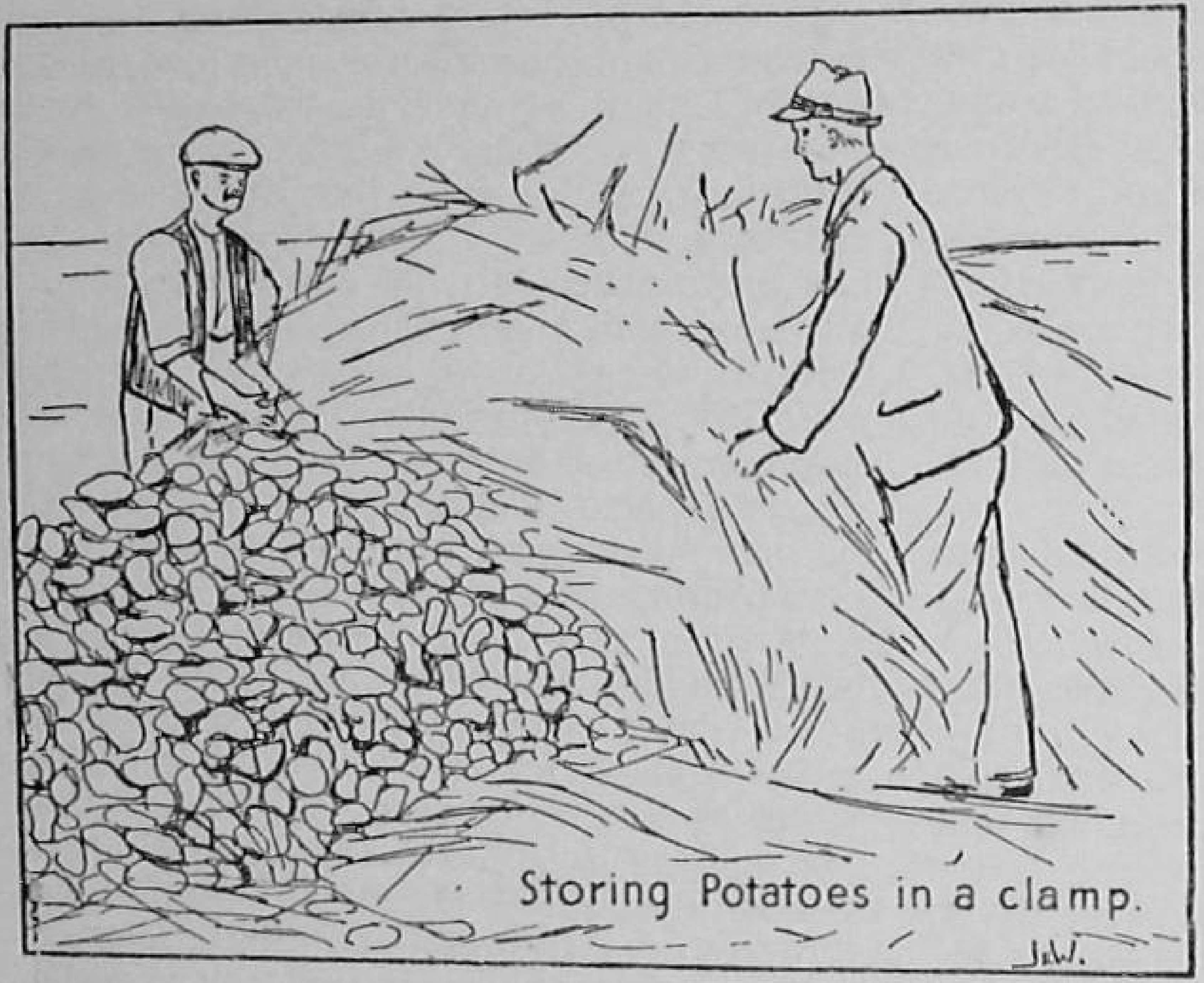


FIG. 14

Early varieties are lifted from the end of May to mid-August; main crop potatoes in September or early in October. The crop should be lifted and used, or stored in a pit and covered up before there is any danger of a hard frost. Early potatoes will only produce 3–10 tons per acre; in the case of main crops the average crop is about 7 tons per acre, but up to 15 tons per acre are frequently grown on good potato land.

Pasture.

Grass is one of the most valuable and one of the cheapest crops which farmers produce.

There are two types of pastures:—permanent pastures, those always carry grass, and temporary pastures (leas or leys) which after having been areas of arable land, are put under grass, clover, sainfoin or lucerne for one, two, three or more years. At the end of this period the ley is ploughed and the land again becomes arable, improved not only by the change and rest from arable crops, but also by the addition of humus.

A pasture can be formed upon any field but it is only where soil conditions are suitable that really good permanent pastures can be established, a process that even under favourable conditions takes a considerable number of years of careful manuring and management.

Pastures vary greatly in quality. First class permanent pastures or as they are sometimes termed fattening pastures will produce sufficient grass to fatten cattle or sheep. On the best of them, in a good season, it is possible to fatten a bullock on an acre without any supplementary food during May, June and early July, and a second beast with the help of a small amount of concentrates during the latter part of the summer. A hay crop is never taken from fattening pastures. There is only a comparatively small area of these fattening pastures in the country, but there is a large amount of good second class pastures. Grass land of this type will carry about one cow on an acre, and during the growing season—May, June and July—will produce enough grass to enable a cow to maintain itself and produce one, two, three or four gallons of milk according to the season and the quality of the pasture. Second class pastures may be either grazed or laid up for one, or two hay crops, and subsequently grazed; while occasionally a crop of grass and clover seeds is taken from pastures of this type.

The ploughing campaign has eliminated large areas of poor grass land, but there is a very considerable area left—usually land which for one reason or another would not make good arable. An effort should be made to improve such grass land. Improvement can be effected in two ways: by surface treatment and manurial dressings to encourage the growth of better herbage, but this notably a slow process. A better and quicker method is to plough and re-seed; a method advocated because an appreciable improvement in both yield and quality can be quickly obtained. Success in re-seeding is largely determined by weather conditions, but much can be done to help the new pasture by careful cultivation and manuring. Two points are of great importance, namely: (1) to ensure that old vegetation is completely buried, (2) to secure a few inches of fine mould on a firm bottom before sowing the seeds mixture. Where there is too much tufty grass or rushes to permit the furrow slice being completely turned over, the roughage should be got rid of before ploughing. Once the old turf has been buried it should not be disturbed and the best implements for preparing a tilth for the young seeds are the disc harrow and the ring roll. Rolling is of great value because it not only helps to form the tilth by crushing clods but it also produces that firm bottom which is so essential to a successful take of grass and clover seeds. If pasture is wanted quickly the usual plan is to dispense with a cover crop* and include either Italian rye grass or 2–3 lb. of rape in the seeds mixture, but in the latter case the rape must be grazed down or it is liable to smother the young seedlings. An alternative is to sow them under a cover crop of oats (3 bushels per acre) or peas and oats, or vetches and oats, cutting the cover crop in early summer and converting it into hay or silage.

Temporary pastures have been for many years a notable feature of British farming. Recently much has been done to popularize ley farming and its value has been increased by the conditions created by war.

There is a variety of types of temporary pastures; clovers, sainfoin or lucerne may be sown alone or mixed with grass seeds. The ley may be left down for one, two, three or more years. The produce may be grazed or made into hay while occasionally a crop of seed is taken.

The value of ley is two-fold. First, a ley will produce two or three times as much food from an acre of land as would be produced by the same land under permanent pasture. For example, a permanent pasture which had yielded about 15 cwt. of hay on an acre for several years was ploughed. After carrying four arable crops it was sown with a ley mixture that produced in two cuts 50 cwt. of hay on an acre in the first year. As far as grazing is concerned a ley will usually carry two or three times as much stock as will similar land under permanent pasture, and if the right species and strains are included in the seeds mixture, keep can be produced both earlier in the spring and later in the autumn from a ley than from a permanent pasture. Another point in connection with grazing is that stock on leys are less liable to pick up parasites than are those grazing permanent pastures.

Secondly, a ley is the cheapest and one of the most efficient methods of building up soil fertility. In this respect the value of a ley is determined by (1) its duration—the longer the ley is left down the greater will be the amount of humus accumulated; (2) the character of the herbage—the greater the quantity of leguminous plants the larger will be the amount of residual* nitrogen; (3) whether the herbage is made into hay or grazed:—when a ley is grazed the manurial residues* are increased by the excreta of the stock.

Seeds Mixtures.

It would be difficult to over-emphasize the importance of sowing a suitable mixture, as this is one of the factors which determines the nature of the herbage produced by a pasture for several years. In selecting a seeds mixture it is necessary to consider the proposed duration of the pasture, the type of soil and the purpose for which the pasture is required—hay or grazing.

Generally a comparatively simple mixture of commercial seeds will suffice for a one or two year ley. A more complicated mixture is desirable for a long ley or permanent pasture. The

examples given below are of mixtures suitable for one, two, three or more year leys.

	One year ley Hay and Graze	Two year leys Hay and Graze	Two year leys Graze only	Three year leys *	Three year leys †	Three year leys ‡
Italian ryegrass§ ..	4	4	—	3	3	—
Perennial ryegrass (ordinary) ..	14	20	20	16	16	18
Perennial ryegrass (leafy)‖	—	—	—	4	4	6
Cocksfoot (ordinary)	—	—	—	2	—	
Cocksfoot (leafy)‖ ..	—	—	—	4	—	—
Timothy (ordinary)	—	—	—	—	3	—
Timothy (leafy)¶ ..	—	—	—	—	3	—
Broad red clover ..	4	2	—	1½	1½	—
Late flowering red clover	—	2	—	1½	1½	—
Alsike	2	1½	—	2	2	—
White clover, New Zealand	—	—	1	¾	¾	¾
Wild white clover**	—	—	—	¼	¼	¼
Trefoil (on calcareous soils)	2	1	1	1	1	1

The figures given represent pounds of seed to the acre.

* Ryegrass with Cocksfoot. † Ryegrass with timothy (for clays and peats). ‡ All-grazing mixture.

§ If sowing without a cover crop increase Italian ryegrass to 10 lb.

‖ Aberystwyth strains and New Zealand certified mother seed.

¶ Aberystwyth S.48 timothy.

** or Aberystwyth S.100 white clover or New Zealand mother seed. This quantity is recommended while supplies are short. In normal times up to 4 lb. of Wild white are sometimes used.

Pasture Manuring.

Methods of manuring pastures vary greatly, much of the permanent grassland of the country does not receive any direct manuring, but even so, if the stock grazing upon it are liberally fed with concentrated foods a comparatively high standard of fertility is maintained. The fertility can be greatly increased by periodic dressings of basic slag; 6–10 cwt. of that manure are applied on many farms once in 4–7 years as routine practice. In recent years attention has been focused on the need for lime, and where slag has not been applied regularly, modern practice is to apply lime. The lime requirements of a soil is a subject upon which the Provincial Advisory Chemist can give very definite information. Another point which has been recently emphasized is the fact that there are quite a number of pastures which are deficient in potash and will respond to applications of that manure. On some farms where the quantity of F.Y.M. exceeds the requirements of the arable land, that manure is applied to the pastures; in most cases where this is done several hay crops in succession are taken from the field or fields. Where F.Y.M. is applied it should always be supplemented with phosphates.

As regards temporary pastures, my observations indicate that the most common method of manuring is to apply a substantial dressing of phosphates and potash, such as: 2 cwt. potash salts, 4 cwt. superphosphate, to the land before the seed is sown. There is much to be said in favour of this practice, for it helps the young pasture-plants to establish themselves and encourages the growth of those very important constituents—the leguminous plants.

Pasture Management.

Pastures do not require much attention, but it is essential that the few operations which are necessary should be punctiliously performed. If neglected, pastures quickly deteriorate. Chain harrowing and rolling in the spring are required to spread mole casts and the manure left by stock. If moles become too numerous the number must be reduced by trapping. Ant banks, if they appear should be dug out and the turf replaced. Thistles should be cut in the spring, and again in the summer if necessary, as they must not be allowed to ripen their seed.

The quality of a pasture is determined in a very great measure by the amount of skill exercised in regulating grazing, and there is a fundamental difference between the methods employed upon really first class pasture and upon less fertile grades. First class pastures will carry stock continuously from the spring to the late autumn. They must not be over-stocked in the spring, for if they are, not only will the stock they carry deteriorate in condition, but the grazing capacity of the pastures for the whole season will be reduced. The herbage of such pastures grows with surprising rapidity during the growing season. Then it must be kept well grazed or it will grow away from the stock, patches becoming too old and fibrous to be palatable. Such pastures must therefore be watched very carefully during the summer, and great skill and judgment is required in regulating the number of stock they carry, for both under and over stocking are uneconomic. Close grazing during the growing season is essential upon all types of pasture, but upon second grade and inferior types, most graziers hold that the best plan is alternately to graze hard and rest for a few days throughout the grazing season. Continuous over-grazing at any period of the year may have the effect of killing out a particular grass and promoting others which may be less desirable. Conversely, carefully controlled grazing can be used to improve pasture.

Pasture plants grow very rapidly between the middle of May and a date in June or July which is determined by the season. In a wet season the period of maximum growth lasts longer than it does under dry climatic conditions. The herbage must be kept closely grazed during the period of maximum growth. The result is that the number of stock grazed per acre between the beginning of May and July must of necessity be greater than the number carried by the pastures from July to the end of the year. This difference is attained in two ways. The first is the removal

and sale of fat stock which relieves the pressure on first grade pastures. The second is the incidence of the hay crop which absorbs an area of the grass land during the growing season, the aftermath providing a welcome addition to the grazing area towards the end of the summer.

Fields from which hay is to be taken are kept free of stock from the beginning of the year until the crop has been cut and stacked. They are rolled and harrowed as soon as sufficiently dry, and thistles are cut in late April. Some farmers are now aiming at securing maximum quality, and to do this it is necessary to cut early—cutting must be done when an appreciable proportion of the plants are *beginning* to flower. The more usual custom is to aim at obtaining the maximum yield, and in this case the crop is cut when the major part of the plants are in full flower. The state of the weather is the factor which determines the actual date of cutting; for fine weather is necessary to facilitate hay-making operations and the general practice is that once the crop has made sufficient growth it is cut on the first favourable opportunity, that is, when there are indications of a spell of fine weather.

There are two methods of making hay. It can be made in the swath.* Under this system, as soon as the exposed side of the swath has dried it is turned over; this process is repeated until the swaths are dry right through, when they are raked into rows from which the hay is collected. Some collect it with sweeps (figure 10), in which case the rick must be built in the field where the crop is grown. Others load it on to wagons either with a hay loader or by hand.

Making hay in the swath is cheap and economical as regards labour and possesses the merit that the shorter pieces of leaf are not lost, which almost invariably happens when the swath is broken up. The alternative method is to rake the swaths into rows as soon as the grass is partly dry and then to build the grass into cocks, in which the drying is completed—there is an art in making a hay cock properly—the cocks are turned until the hay is dry, when they can be either swept to the rick or loaded onto wagons. Cocking is almost universal in the wetter districts, and is occasionally adopted even in the drier parts of the country. Exponents of the method declare that it is the only way to cure grass fully and retain the maximum amount of green colour.

A hay crop from permanent pasture will yield 15–25 cwt. per acre, while up to 50 cwt. can be obtained from temporary pastures.

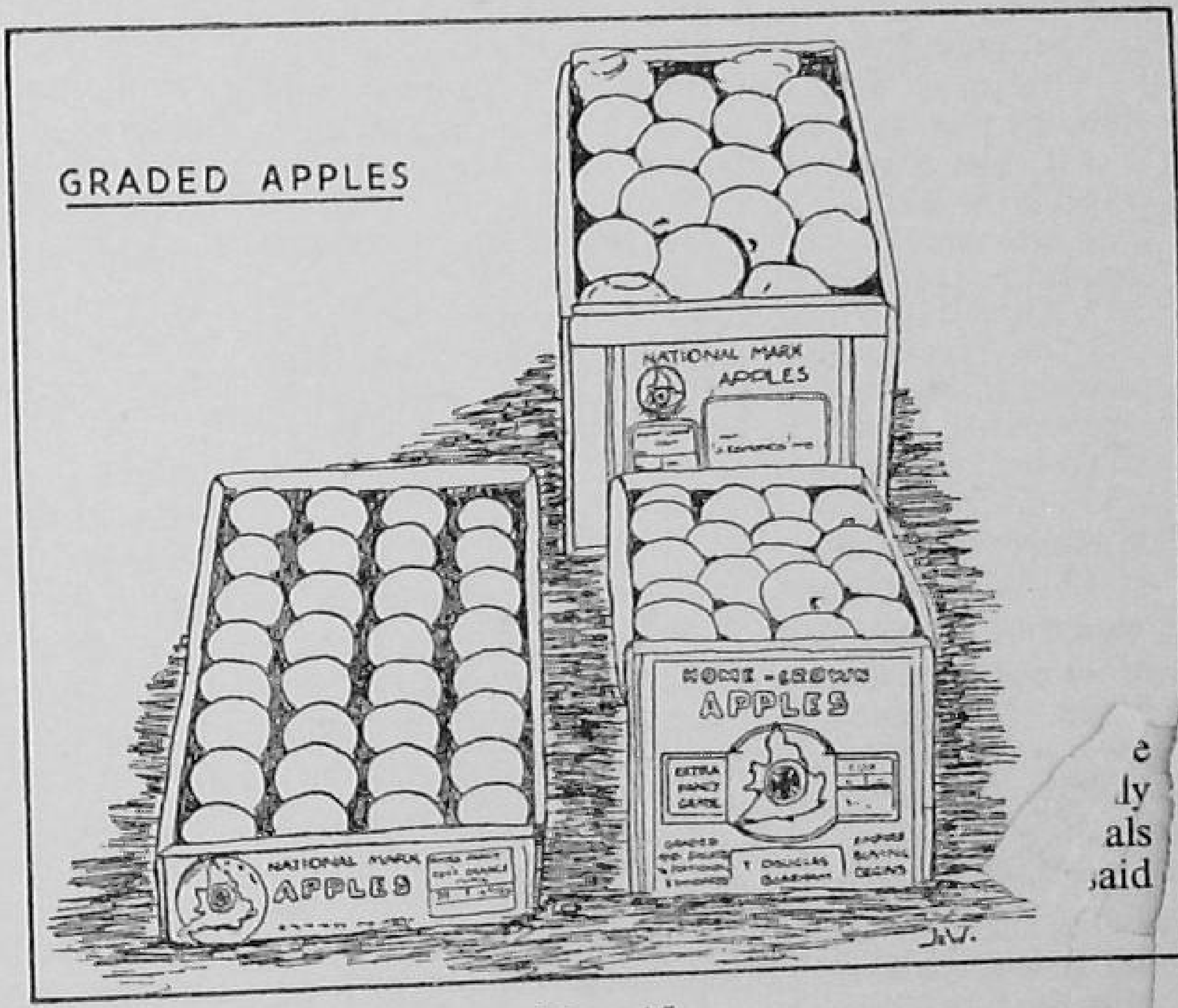


FIG. 15

Market Garden Crops.

These crops, at all times an important unit in the output of our farms, are likely to become even more important in the future owing to the tendency to increase the amount of processed foods imported. For as the proportion of processed foods in the diet rises, so does the need for protective foods. Many holdings are devoted entirely to the production of market garden crops; they also form part of the output of some general farms, and at times are cultivated in association with fruit.

There is a considerable number of market garden crops, and a lack of uniformity in the methods employed by different growers; but there are a few points in connection with them which are of general interest.

All of them need a deep soil which is in good heart, while efficient cultivation and judicial manuring are essential to success. A comparatively large amount of labour is absorbed in their cultivation and marketing. Most of them are perishable and must be consumed shortly after they are picked or cut, and the demand being strictly limited, the market can easily be glutted. Thus growers need an intimate knowledge of market conditions, which must be kept under constant observation. These crops are even more susceptible than the common farm crops to the influence of weather, production costs are high, and returns uncertain, and market garden crops must be regarded as a highly speculative investment. A high degree of adaptability in farm management is called for because two or more crops are frequently grown each year on the same land.

Fruit Growing.

A survey of farm crops would be incomplete without some reference to fruit growing. This is another highly specialized important section of the farming industry. The points raised in the preceding paragraph are applicable to fruit. Fruit growers are even more at the mercy of the weather than are market gardeners, for one night's frost at blossom-time may, and frequently does, dispose of all chance of a fruit crop for a year.

At one time home-grown fruit compared unfavourably in appearance with that of the best imported, a fact that tended to discount the value of the superior flavour of the home-grown article. The introduction of methods of disease and pest control, combined with efficient sorting and packing has completely altered this within recent years. Although there is still a considerable amount of fruit marketed in an unsatisfactory condition, to-day a large proportion of the home-grown crop is placed on the market in a more presentable condition than is the imported, a fact which combined with the superior quality of home-grown fruit secures for it a ready sale.

FARM LIVE STOCK

This section, after a general review of the subject of Stock Breeding, deals briefly with Horses and goes on to give some general notes on the feeding of stock. There follows a preliminary account of British breeds of Cattle, Sheep and Pigs, subjects more fully considered in sections of Vol. II of the present work. Commercial stock—Cattle: merits of specialized and dual purpose types; points of beef, dairy, and dual purpose animals; dairy, dual purpose and beef breeds—Sheep: points of a good sheep, short-woolled, long-woolled and mountain breeds, cross bred sheep—Pigs: market requirements, the breeds and their utilization.

SUCCESS in animal husbandry is due to a combination of good breeding and economical feeding. The prices of the finished products are the overriding consideration which determine whether a profit or loss is made. But if a fair price can be made, a good animal will always make a better profit for both breeder and feeder or dairyman than will a bad one, while if prices are bad less will be lost on a good than on a bad animal.

STOCK BREEDING

Some General Principles.

The farmers of these islands have had a considerable amount of skill in the art of breeding stock for many centuries. Those who can remember the type of joints sold as prime home-fed meat at the close of last century, and can make a fair comparison with similar joints sold before the war, will appreciate the improvements made in quality. At the end of last century large rather coarse fat joints were offered as prime home-fed meat; whereas before the war small prime quality joints were produced that had a small proportion of fat and bone and were unrivalled in flavour. And if it is remembered that these improvements were made by moulding living animals the magnitude of the achievement will be appreciated. In addition to what has been done for the home industry, British live stock has been used for improving the local breeds of most of the important meat-exporting countries. The breeding stock which is now being used in these countries owes its *quality* to the influence of British live stock which in this way has also been largely responsible for the high quality of the meat which is now imported.

The art of breeding is based on two facts: (1) that like begets like, (2) that no two animals are *exactly* alike. A good breeder forms in his mind a mental picture of what he considers to be the ideal type of animal, and endeavours to pick animals for breeding that conform as nearly as possible to that type. Thus he is, or should be, mating animals of similar type, and if his judgment proves to be good a large proportion of the offspring will conform closely to that type. But an animal has a large number of characters, and it is not equally good in all of them, in this respect no two animals are alike. The skilful breeder is constantly striving to mate animals in such a way that their offspring will possess most of the best characteristics of both parents.

There is generally a considerable amount of similarity between animals which belong to the same family; the founders of modern breeds often utilised this fact and mated related animals, a practice known as in-breeding. It is occasionally useful in the hands of a skilful breeder because in-bred animals are almost invariably very uniform in type. None the less it is avoided as far as possible because the idea is firmly rooted in the minds of many breeders that constitution can be undermined by in-breeding. Generally speaking, there is no need for in-breeding to-day, for every breed society contains a number of good breeders, and though they are not *all* working on identical lines—a number of different types are to be found in all breeds—there is always a certain number of breeders who are working to produce similar types of animal. This makes it possible for a man who knows his breed to obtain suitable unrelated sires for any females he desires to mate.

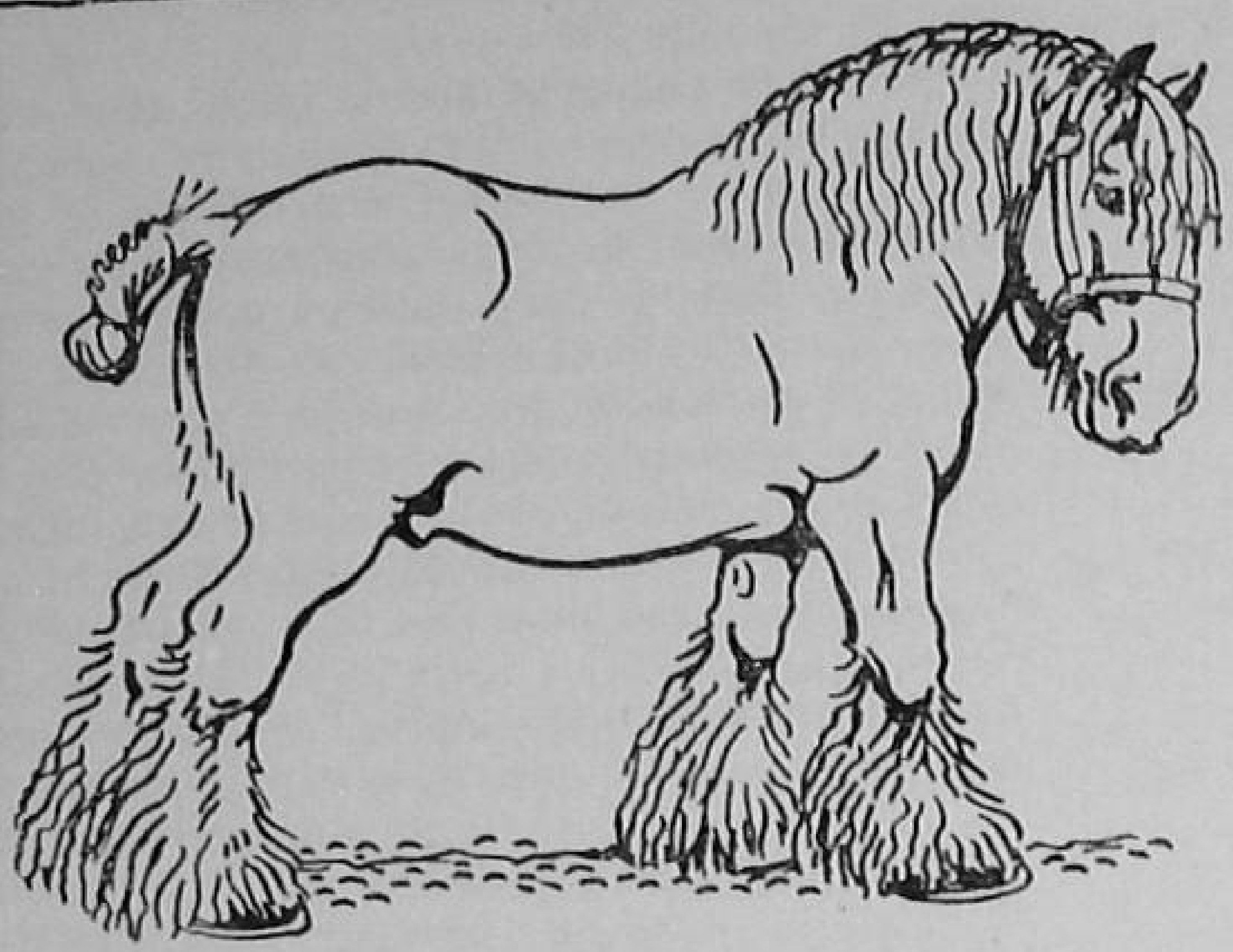
Breed Societies and Their Work.

British live stock owes much to the activities of the breed societies. Their functions are to compile herd books, and to look after the general welfare of the breed. When a breed society is first formed it is necessary to allow animals to be registered in the herd book, which are found on inspection to conform to breed type, and this practice is usually continued for several years; while it is in vogue the herd book is said to be "open." When a society becomes firmly established only the progeny of registered animals are eligible for entry, then the herd book is said to be "closed."

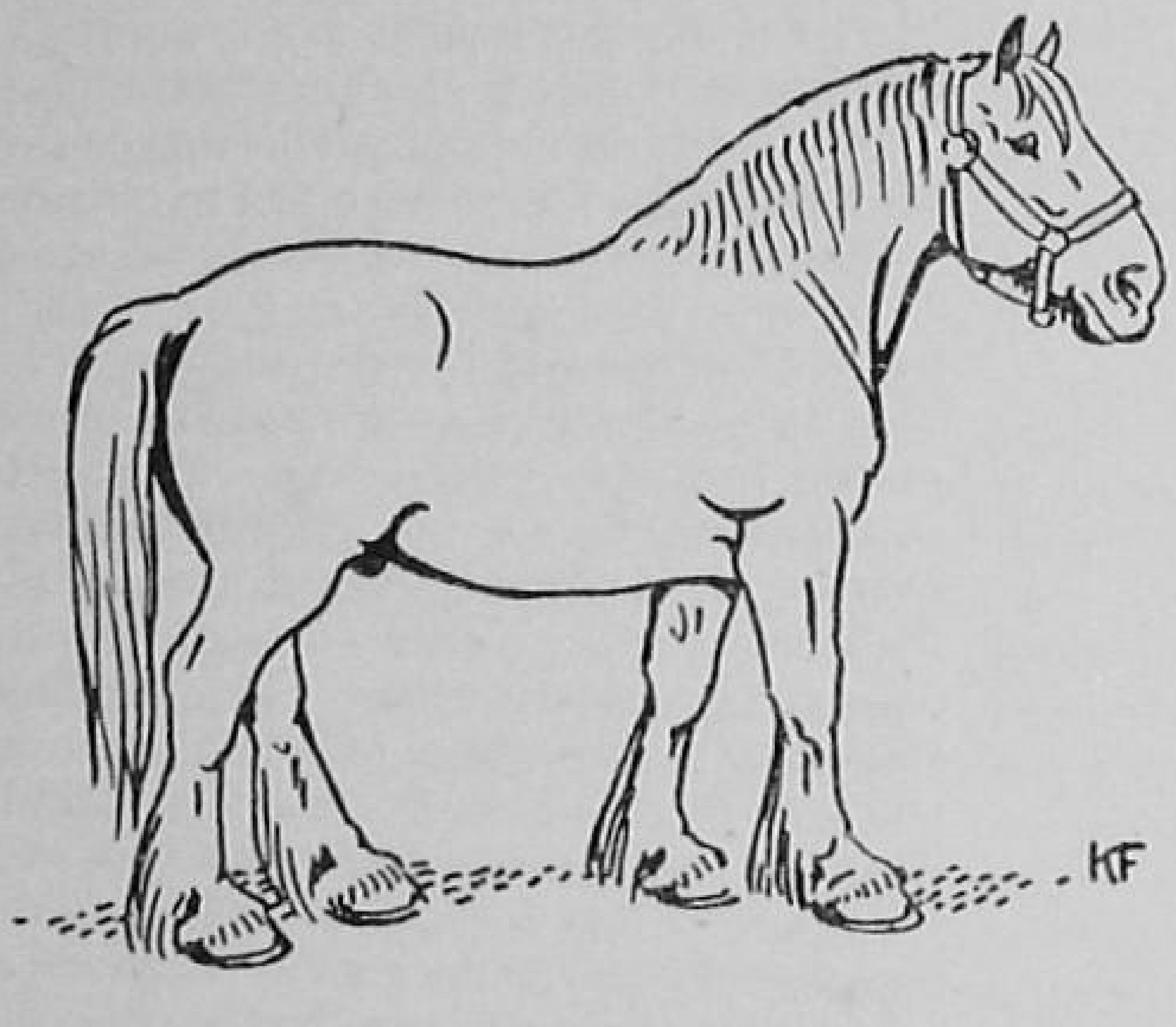
The term "pedigree stock" is frequently used in respect of registered stock because it is possible to trace the pedigree of such stock in the herd books for generations. It will be noted that a pedigree is not necessarily a certificate of merit; its value depends on the merits of the various sires and dams, and the way they nick* in with one another.

A breeder who desires to register an animal must join the breed society and is also required to pay a small fee for each animal registered.

The second function of a breed society is to look after the general welfare of the breed. Their main activity in this connection is to organize competitions, most of which are held at agricultural shows. These competitions have provided breeders with a means of testing their skill. Their value, which in the past depended entirely upon the skill of the judges, has within recent years been materially increased by the introduction of



A type of farm horse quite common fifty years ago



A modern farm horse

FIG. 16

quality tests, i.e. carcass competitions for butchers' animals, and of milk yield competitions and milk recording for dairy stock. Much of the best live stock of this country has been raised to such a very high state of perfection that if further improvement is to be effected, more refined methods of assessing merits must be used than those employed in the past. Thus quality tests are an important step forward because they provide a more exact method of judging the performance of an animal than does the eye of even the most skilful of judges.

Commercial Stock.

It must be admitted that on the majority of the commercial farms of this country, non-pedigree females are kept, but pedigree sires are almost invariably used. No stallion or bull may be used for breeding unless it is licensed by the Ministry of Agriculture, and the Ministry's inspectors will only license suitable animals. The reason for this is very largely a matter of economics, in many cases a non-pedigree female will cost very much less than a pedigree female of comparable merit. A good non-pedigree female will as a rule produce offspring that are quite useful for commercial purposes if mated to a pedigree sire, but they produce offspring of inferior quality if mated to a non-pedigree sire. There was at one time another reason which does not hold at the present time. At the end of last century pedigree breeders paid a large amount of attention to the meat producing capacity of their stock, but many of them paid less attention to their breeding propensity. This has been altered, now there is a large number of pedigree breeders who pay as much attention to the performance of their animals as to their breed points, and the number is growing rapidly, Pedigree with performance is now the guiding principle of many pedigree herds.

HORSES

In spite of the advances which have been made in tractors and tractor-drawn implements, horses still occupy an important position on most farms. The great majority of working horses are non-pedigree animals but almost without exception pedigree stallions are used for breeding. The result is that horses conform to a certain extent to one of the breeding types. Of the four breeds of heavy horses found in the country, the Shire type is the most generally popular in the Midlands and South of England, and the Clydesdale in the North of England and Scotland. There is an area in the eastern counties of England where the Suffolk Punch predominates. The comparatively small number of Percherons are scattered widely over the country.

The Shire is the biggest of all breeds of horses. A mature stallion should be 17–18 hands, and a mare 16–17 hands high. Typical animals have a small head, strong neck, wide chest, well-sprung ribs, deep quarters, big feet and legs of flat bone. The hair on the legs should be fine, silky and free from any tendency to wiriness or curl; the quantity should not be excessive. They are to be found in practically all colours: black, grey, brown and roan. A horse not quite so

heavy is now generally preferred for farm work, and Shire stallions are frequently mated with grade mares which have comparatively light clean legs. Somewhat less massive than the Shire is the Clydesdale—a very active horse with comparatively light clean legs. A mature stallion of this breed is about 17 hands high. Bay or brown, with more or less well-defined white markings on the face and legs are the favourite colours; occasionally blacks and chestnuts and roans occur.

The Suffolk Punch, which is characterized by a thick-set body on short legs, has gained an unrivalled reputation for its willingness to face a "dead pull." A clean-legged horse, it is an excellent mover with a quick step; 16–17 hands high, the typical colour of the breed is chestnut, of which there are seven different shades recognized. The Percheron is not quite such a heavy horse and is distinguished by clean sound legs, deep wide body and great activity.

Feeding Horses.

The rations in general use for horses are based on the experience of practical horse keepers. As regards coarse fodder, hay is preferable to straw when it can be spared, and if straw has to be included in the ration, oat straw should be used. Wheat straw is not a desirable horse food. Oats are the concentrated food most favoured, but a proportion of beans and maize may be included in the ration when prices make that desirable. During the summer no hay is fed to those farm horses that are allowed out to graze, but they receive an allowance of corn, the quantity being regulated according to the amount of work performed—up to 12 lb. per day of oats are fed, half that quantity usually being sufficient. A very satisfactory winter ration for a heavy farm horse is 16 lb. of hay, and 12 lb. of oats, and many farmers give their horses a bran mash at week-ends if they are lying in the stable.

CATTLE

Three classes of cattle are kept in this country: (1) Dairy cattle—these have been selected for their capacity to produce milk, and in most cases their carcasses if fattened are only of second grade quality. (2) Dual purpose cattle—these produce a moderately high milk yield—the average would be about 75 per cent of that of the heavy yielding dairy breeds—and their carcasses when fattened are first grade, but not as a rule super grade. (3) Beef cattle—these have been selected for their capacity to produce high grade carcasses. The cows of this class usually give only a small quantity of milk, no more than is required to rear their own calf.

There are two schools of opinion, one of which holds that the specialized types, i.e. dairy cattle and beef cattle, are more economical than dual purpose cattle. The other school holds the opposite opinion.

Those who belong to the first school claim that the cost of production of milk in a herd is mainly determined by the average annual yield of the cows, and that heavy yielding dairy cows give sufficient milk to keep the cost of production down to an economic level. In their view the value of the heifer calves from a heavy yielding dairy cow to a dairy farmer is greater than that of *all* the calves from a dual purpose animal. Thus the fact that many bull calves from the heavy yielding cow may be of but little value is of no significance.

The advocates of specialized beef cattle claim that the financial return from beef production is largely determined by (1) an animal's capacity to utilize food economically, (2) the price per cwt. realized by the finished animal. They state that a good beef animal can utilize food for meat production more economically than other types of cattle, and the fact that the proportion of super grade carcasses is higher than amongst the other types is unquestionable.

The second school claims that high yields are not necessarily an economic proposition. They point out that expensive feeding is necessary to enable a cow to produce a very high yield, also that it is necessary during part of the lactation period to milk three times a day, two factors which make the cost of obtaining very big yields comparatively high. They claim that dual purpose cattle are more hardy and of stronger constitution than heavy milking cows of the dairy type and that losses amongst the latter are proportionately higher than amongst dual purpose type cattle. They also claim that with beef cattle the cost of producing and rearing a calf to six months old from a cow which only produces enough milk to rear its own calf is unduly high, and that the money saved on a dual purpose animal prior to the time it is six months old far exceeds the additional price secured for the better quality of a beef animal.

The writer would point out that British farming is so diverse that in it there is a place for all three types and not one of them is the most suitable for all farms. The man who has a small or medium-sized dairy farm in a thickly-populated district needs to produce the maximum quantity of milk per head each year from his cows, and in his case heavy yielding dairy cows are desirable. Another farmer whose holding is in an outlying district may find that a beef type of animal is best for his farm, because with it grazing can be done with the minimum amount of labour. Then on a mixed farm where the dairy herd forms only part of the stock, and cattle are required for grazing, a dual purpose breed will usually be preferable.

Points of a Good Beast.

There are some points that are to be found in all good beasts, and it will save repetition if these

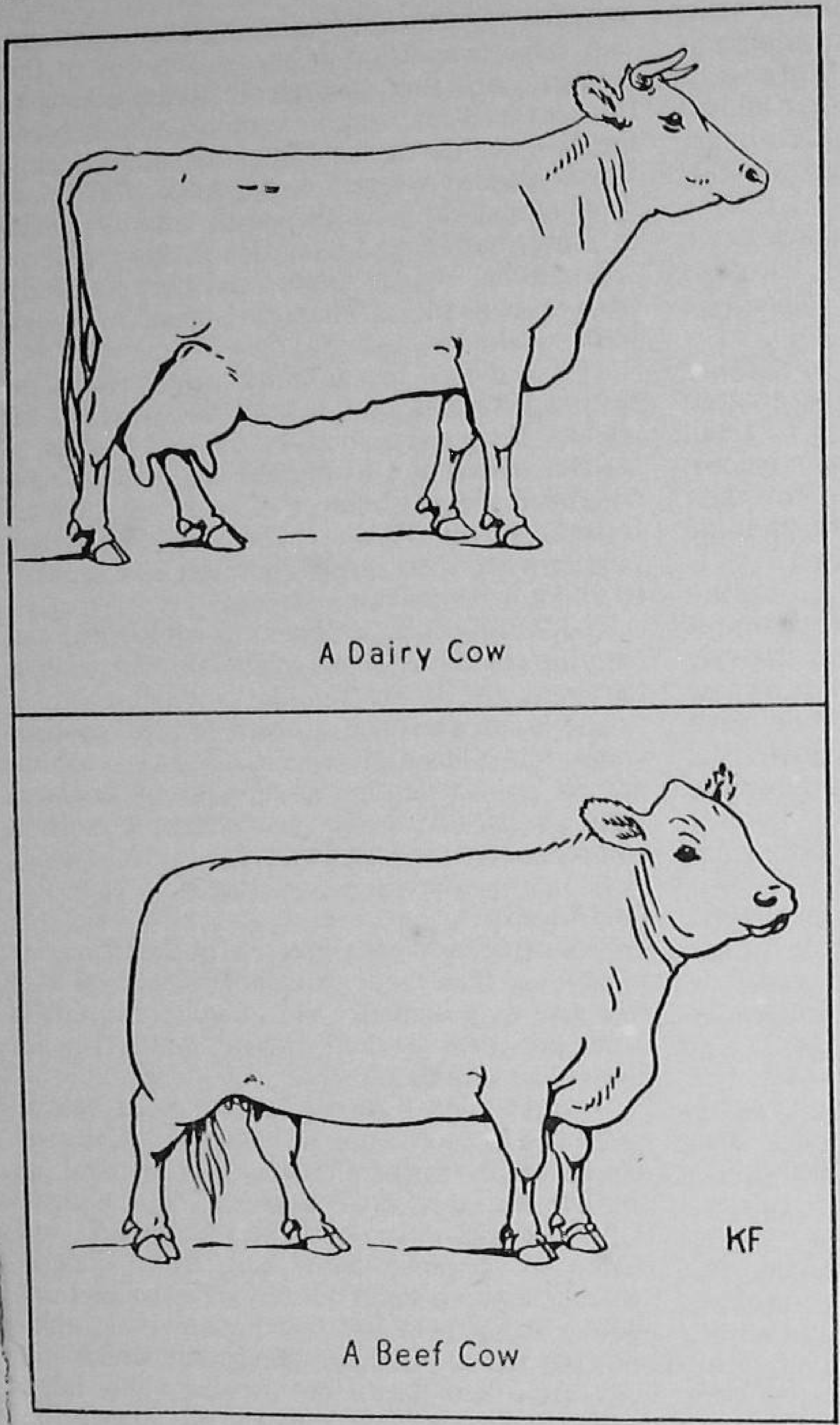


FIG. 17

are enumerated before discussing the different types of cattle. A good beast will have a " gay " appearance suggestive of quality and a free action when it moves. Horns, when present will be fine in texture and refined in form. The eyes will be large, clear, and have a placid expression. The ears, which will be fairly large and mobile, will be joined neatly to the head. The body which will be moderately long with adequate heart room will be wide across both the hip and pin bones, and there will be adequate length between hip and pin. The tail will be well set, fine and fairly long; the legs straight and strong with fine bone and shapely feet. The skin will be of medium thickness, soft, mellow and elastic; the hair fine and silky.

A good beef beast (figure 17) in general appearance is symmetrical and compact, being more or less rectangular whether viewed from the side or from above. It has a short head which is broad at the forehead with prominent open nostrils, the neck short or medium in length merging neatly with the body at the shoulder. The upper-line from top of tail to the poll is almost straight except where it rises in the crest of a bull. The body, which is deep and rounded, is evenly covered with flesh, free from roughness at the shoulder and hip bones, and from patchiness. The hind quarters are full and well covered down to the hock.

A typical dairy cow (figure 17) in general appearance is more or less " wedge shaped " when viewed from the side or from above. It is rather more feminine and leaner in appearance, particularly in the head, neck, shoulder, withers and thighs than the typical beef animal. In some of the best dairy animals the top line is straight but frequently there is a clearly marked rise between the loin and tail and a depression or hollow in the quarters. The udder should be of great capacity without being pendulous or fleshy. The forequarters of the vessel before milking should extend well forward and be close to the body, the sole, from which the teats hang should be horizontal and attached high and well back. The teats ought to be of uniform size, squarely placed and well apart, being neither too large nor too small for convenience in milking. Two large, tortuous milk veins should be found, one on each side under the belly.

A typical dual purpose cow will have a conformation corresponding to the beef type, and at the same time a well-developed udder and milk veins. She should possess the ability to give a comparatively large amount of milk.

It should here be noted that there is no clearly marked line of demarcation between the three types, also that in a breed like the Shorthorn, all three classes—dairy, dual purpose and beef types—are to be found.

The Dairy Breeds.

Dairy breeds can conveniently be divided into two classes (*a*) breeds which give a high milk yield, and (*b*) breeds which yield milk of very high quality.

(*a*) *Breeds which give a very high yield.*—In this class are three breeds which have gained an international reputation. They have produced a

number of cows yielding 2,000 gallons a year, and annual yields of 1,000 gallons are comparatively common amongst them. Herds are to be found in which the cows have produced an annual average yield of 1,000 gallons. Ordinary commercial herds will often average 800–900 gallons under normal conditions.

The British Friesian is a breed which has a characteristic black and white colour. The cows reach a very large size and are heavy milkers—a number have reached 3,000 gallons.

One section of the Shorthorns—the Dairy Shorthorn—belongs to this class. The animals of this breed, which was developed in England are large in size, and red, white or roan in colour. The cows are hardy and remarkable for their adaptability. They are good grazers and are seen to best advantage on good pastures.

The Ayrshire is a Scots breed which has made a reputation for itself because of the capacity of its neat cows to find a living on comparatively poor pastures. These animals are red, brown or white, or a mixture of these, each colour being distinctly defined. They have characteristic horns which are set widely and incline upwards. The udder conformation is another notable feature—that of many of the cows approaches what is generally accepted as the ideal.

(*b*) *Breeds which yield milk of very high quality.*—The two breeds in this class are notable for the quality of their milk, which usually contains about 5 per cent of butter fat and frequently exceeds that figure.

The Guernsey: its colour—light fawn or lemon, is nearly always broken with white patches; the cows are of medium size and comparatively heavy milk records of 1,000–1,500 gallons appear regularly in the Society's register, with an occasional yield of 2,000 gallons.

The Jersey is a somewhat smaller animal, the colours of which are fawn, mulberry, broken fawn and white, mulberry and white, and silver grey. Jerseys are graceful animals with a typical dairy cow—wedge shaped—appearance. Considerable attention has been paid by many breeders to performance, and the breed contains a number of cows that have produced high yields of rich milk—yields of 1,000 gallons containing 5 per cent of fat, are comparatively common, and there is an appreciable number of cows with yields of between 1,500 and 2,500 gallons of milk, having a fat content of over 4·5 per cent. Jersey milk has acquired a well-merited reputation for quality and will usually command a comparatively high price. The animals of this breed mature early; heifers often calve at two years of age.

The Dual Purpose Breeds.

In this class is included breeds of which individual cows do not as a rule produce more than 800 gallons of milk in a lactation. The yields of commercial herds are 600–700 gallons per annum. Steers and heifers if fed well produce first class—but not as a rule super grade—carcasses.

A large proportion of the Shorthorns of this country, including the Lincoln Reds, belong to this class. They vary in conformation between the large cattle of the Midlands, which incline towards the wedge shape, and the more symmetrical cattle of the north country, which in conformation tend towards the beef type.

Somewhat similar to the dual purpose Shorthorn except in its characteristic colour—blue roan—is the Blue Albion.

The Red Poll breed, which originated in the eastern countries of England, has travelled far afield. Deep red colour—white on the udder or a silver haired end to the tail are permissible—combined with the absence of horns are the main features of this breed. The cattle owe their popularity to their thrifty character and capacity to find a living on poor pasture.

The Welsh Black is a breed which is worthy of mention because of its constitutional vigour, hardiness, thriftiness and adaptability.

The South Devon is a breed of medium-sized cattle, which has a characteristic light red colour, and is popular in the south-west of England. Animals of this breed produce milk with a comparatively high fat content.

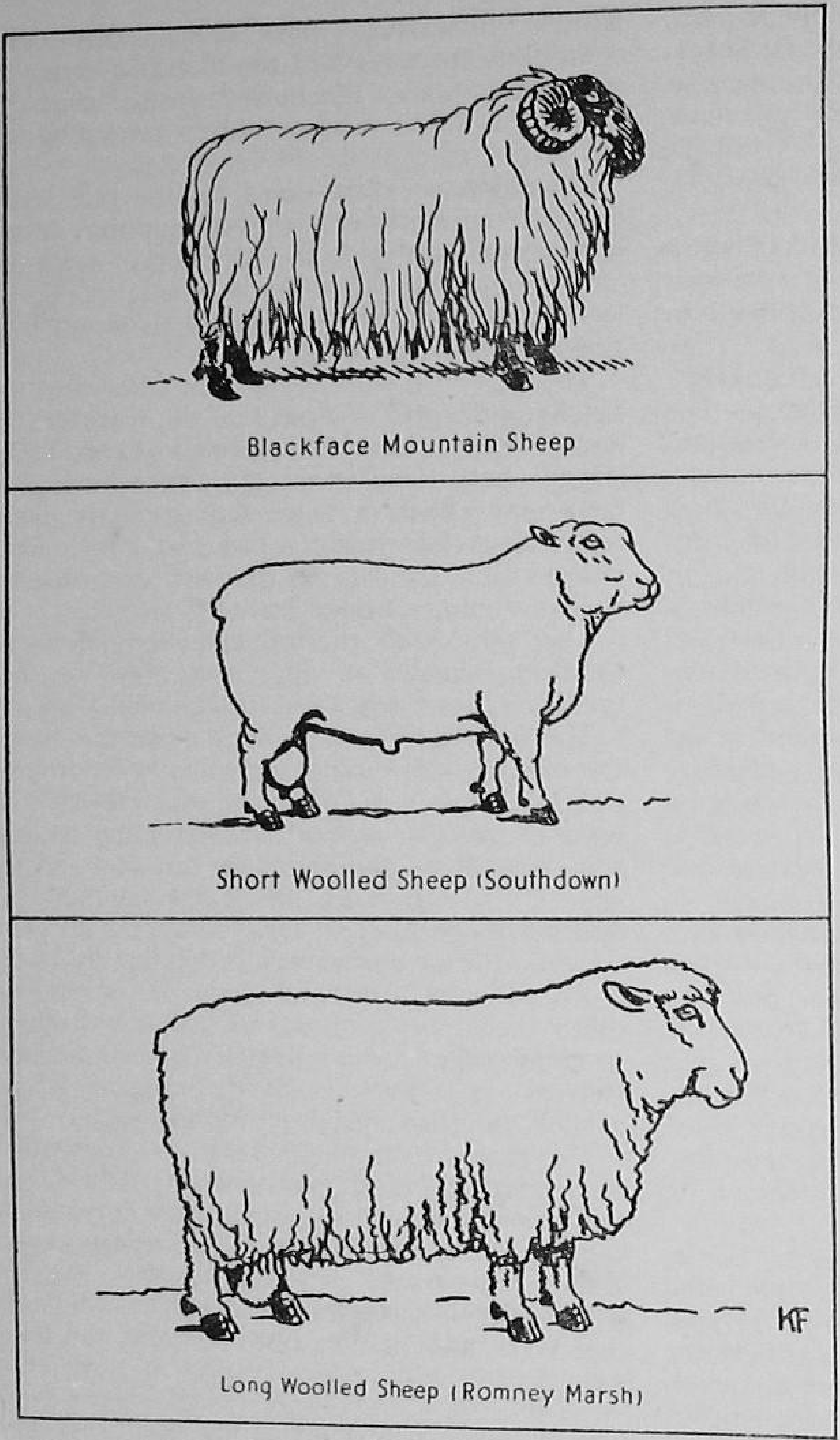
Beef Breeds.

Beef cattle have been selected for their capacity to produce high-grade carcasses. The cows as a rule give only a small yield of milk, and this is usually reserved for their own calf which they are allowed to suckle.

The Aberdeen Angus is a breed which originated in Scotland. A really good Aberdeen Angus beast (figure 17) may be regarded as approaching the ideal type of beef animal. Polled, black in colour, very compact and beautifully covered with lean meat that is associated with a small but not excessive amount of fat. Animals of this breed are popular alike both butcher and feeder. Prepotent sires,* the bulls are often used for crossing, and large numbers have been exported for grading up the herds of other beef producing countries. A very close rival of the Aberdeen Angus for the title of the premier beef breed is the beef Shorthorn, examples of which are also to be found in all the principal beef producing countries. Aberdeen Angus and beef Shorthorn cattle are both excellent as grazers and as yard-fed cattle.

Developed primarily for fattening on the rich pastures of the West Midlands, the Hereford breed has gained a world-wide reputation as a grazing beast. These cattle, which, when mature, make up into very large beasts, are red in colour with white head, chest and brisket.

The North Devon and the Sussex breeds are deep red in colour. Both have been greatly improved in recent years, and now reach maturity early and finish at medium weights, thus producing the small joints required by modern



Blackface Mountain Sheep

Short Woolled Sheep (Southdown)

Long Woolled Sheep (Romney Marsh)

FIG. 18

conditions. The North Devon has been developed on the lush pastures of the West Country, and the Sussex on the poor thin pastures of the Chalk Downs.

Slower in reaching maturity are the Galloways, of which there are black and belted types. They are polled cattle, capable of thriving in a cold wet climate. Even more hardy still are the West Highland cattle which, with their wide horns and long coats of straight and shaggy hair, black, red or dun in colour, may well claim to be the most picturesque of all British cattle.

SHEEP

There is a considerable number of breeds of sheep in this country because there are many districts which have developed types of their own. In some instances these local breeds have characters which make them specially suitable for local conditions. It will not be possible to deal in detail with all of the breeds, but they will be divided into groups, and one or more of the breeds from each group will be briefly described.

British sheep are kept mainly for their carcass, but the wool is a very important secondary product. In this country under normal conditions the fat lamb trade starts at Easter, and fat lambs straight off their mothers continue to come on the market throughout the summer. This market only absorbs a small portion of the lamb crop, the main portion are weaned towards the end of the summer, and are then known—the females as tegs, the castrated males as wethers. Large numbers of tegs and wethers are fattened off on roots during the autumn and winter months. The remainder are run through the winter as stores to be fattened on the pastures as yearlings. Except for draft ewes the practice of fattening older sheep has been very largely discontinued in recent years.

Points of a Good Sheep.

It will save repetition if the points which are common to all "good sheep" are enumerated before discussing the different types.

A good sheep should have an alert appearance and an easy, graceful carriage. It should have a well-carried head, broad across the bridge of the nose, with full, bold, bright eyes. In the ram the head should be masculine without being coarse, and in the ewe it should be refined but not weak. The neck should be thick towards the trunk, fitting well and evenly into the shoulders, which should be well laid and covered with firm flesh. The region behind the shoulders should be level and free from hollows. The back should be level and broad throughout its length. (Some of the mountain breeds are exceptional in that they have sharp shoulder tops or withers.) The animal should be evenly covered with firm flesh. Both top and underline should be straight; the ribs should be deep and well sprung, the chest broad, deep and projecting well in front of the forelegs, the thighs and fore-flanks thick and well-fleshed; the quarters long, deep and wide, not drooping towards the tail and with little space between them and the last ribs; the legs should be straight, not too long, the bone clean and fine. The wool should cover the whole body evenly.

The British breeds of sheep can be divided into three groups which are usually termed: (1) Short-woolled; (2) Long-woolled; (3) Mountain and Moorland.

The Short Woolled Sheep.

First, there is that very notable group the Down breeds: Southdown, Shropshire, Suffolk, Hampshire, Dorset and Oxford. All are hornless with dark faces and legs; their fleeces are of medium length and have excellent quality fine wool. They produce carcasses of prime quality, the flesh being firm, fine in the grain and rich in colour. The rams of all these breeds are prepotent sires and they have been widely exported for improving the sheep of other countries. The high quality of much of the mutton and lamb imported into this country to-day is largely due to the influence of these breeds.

The Southdown, which are the smallest and most compact sheep of the group have mouse-coloured faces and legs and they carry the shortest fleeces. Their wool is the finest produced in the country; and they are seen to the best advantage on poor land, being apt to get too fat on good pastures. Maturing very early, they are excellent for fat-lamb production. Their small size and neat conformation as well as the high quality of their flesh make them valuable for crossing with large sheep of less quality, and the rams are much in demand for this purpose.

The Shropshire, Hampshire, and Dorset are slightly larger than the Southdown, and produce slightly longer and somewhat coarser wool. They have black faces and legs and the wool is carried over the forehead—they respond to liberal feeding and can be kept on good pastures or folded on arable crops.

The Suffolk deserves special mention. Somewhat similar in size to the Hampshire, this breed is characterized by a jet black face and legs and by the fact that the wool is not carried over the forehead. It is notable for the large proportion of lean meat in the carcass, a feature which makes it popular for crossing purposes.

The Oxford is the largest and heaviest of the Down breeds, and has a long open fleece—it might almost be classed as a long-woolled breed. It is essentially a breed which responds to good treatment.

Somewhat similar to the medium-sized Down breeds are the Ryeland and the Kerry Hill. Animals of both breeds carry a fine fleece of medium length and both have gained favour in recent years through the demand for a medium sized ram for crossing. Ryelands have attained popularity also in Australia and New Zealand. On grass farms in the Midlands the Kerry Hill has gained considerable popularity.

The Dorset Horn is a very striking breed—the face and legs are white and the fleece short and fine. The rams carry large curved horns. This breed has a well-earned reputation for early lamb production, and under favourable conditions the ewes will produce two crops of lambs in a year. The rams are often used for crossing with other breeds where fat lambs are the objective.

The Wiltshire Horn breed has the peculiarity that it produces little or no wool and that its use is restricted largely to the breeding of rams for crossing purposes for early fat lambs.

The Long Woolled Sheep.

The principal breeds in this class are the Leicester, Border Leicester, Lincoln, Wensleydale, South Deven, Devon and Romney Marsh. The sheep of all these breeds grow to a large size, have almost white faces and legs and carry a very heavy fleece which is composed of long, coarse wool. They are seen to the best advantage on rich pastures or arable land. The carcasses of mature sheep are rather too large to be regarded as prime quality to-day, and they are frequently crossed with one of the smaller breeds.

The Leicester is notable for the fact that it was the first British breed of sheep to be improved; none the less it still holds its place to-day—its value is due to its production of lean mutton. On this depends its popularity for crossing and for export. Though a secondary consideration, the fleece is of considerable value because of its great weight—a shearling ram will clip up to 18 lb.

The Border Leicester, a breed which has established itself in Scotland and the north of England has gained a reputation amongst export buyers. It is the sire of perhaps the largest number of cross-bred sheep in the country.

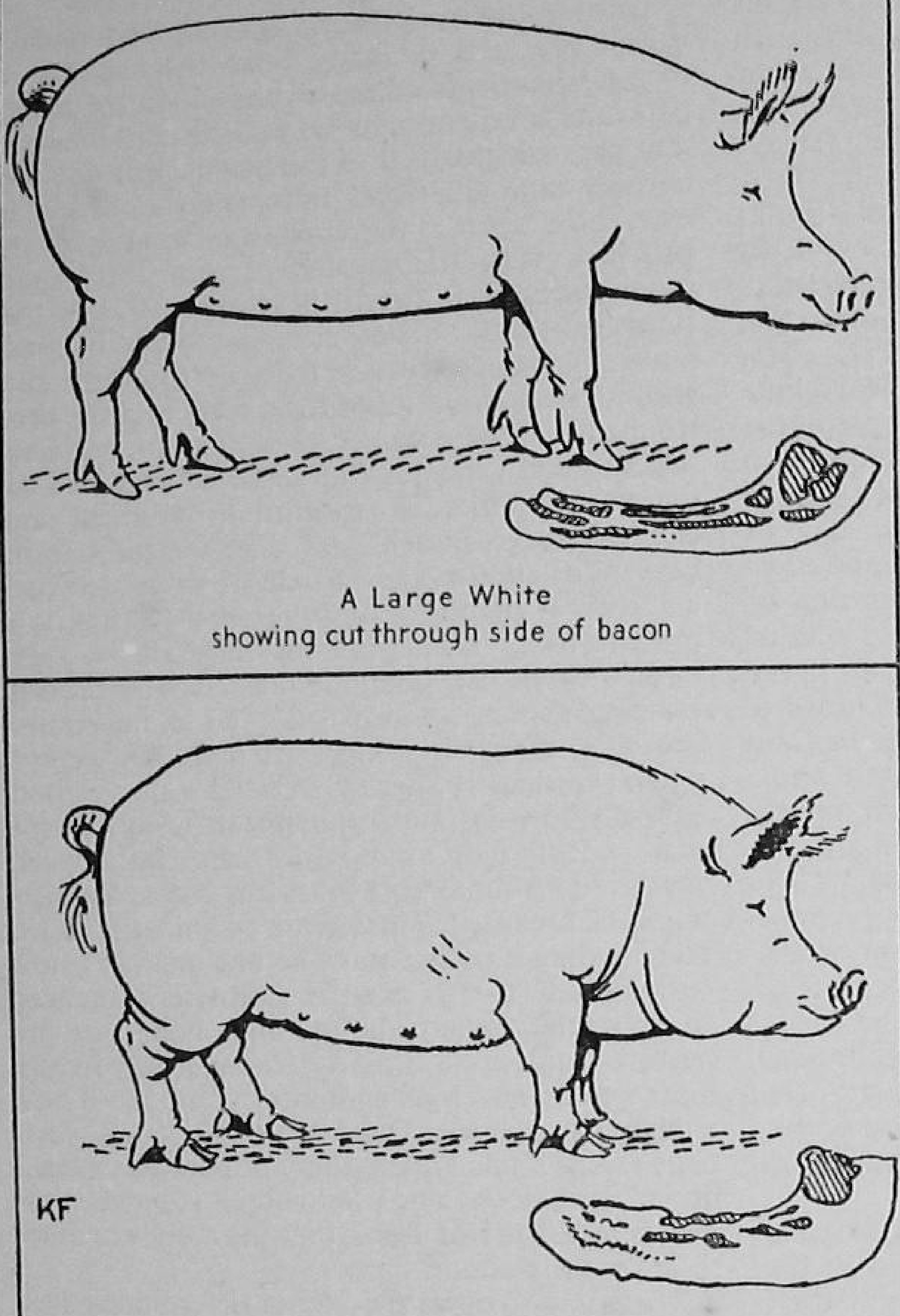
The Kent or Romney Marsh is a breed which will thrive upon lush pastures. Its strong wool has gained in popularity both in New Zealand and the Argentine, and there is a considerable export trade for the rams.

Clun Forest sheep are popular in the Midlands and West, and yield excellent mutton and good wool.

The Mountain and Moorland Sheep.

It is convenient here to group together a number of breeds which are characterized [illegible] their ability to thrive on poor food distributed over a large area. The sheep are very active and produce a comparatively heavy fleece. In their native haunts they mature slowly, but the lambs as a rule fatten readily if brought on to better keep. Of these breeds the Blackface, Cheviot and the Welsh Mountain are best known; but the Dartmoor, Derbyshire, Gritstone, Exmoor, Herdwick, and Lonk, have also acquired more than local reputations.

The Blackface is one of the most picturesque sheep in the world, and at the same time one of, if not, the hardiest. The face and legs are black and both ewe and ram carry horns. They are very compact short sheep and their long fleece reaches nearly to the ground. The mutton is of



A Large White showing cut through side of bacon

A short thick set pig showing cut through side of bacon-This is too fat for modern taste

FIG. 19

the highest quality at all ages. The majority of the wether lambs are now fattened in their first autumn or winter, but lambs weighing 25–30 lb. dressed carcass, are sometimes marketed direct from their mothers. The loose, shaggy, wavy wool is very strong and is used for carpet-making, being exported to the U.S.A. for that purpose; ewes clip $3\frac{1}{2}$–$4\frac{1}{2}$ lb. and wethers up to 7 lb. Its home is the Pennines of England and Highlands of Scotland where it lives in the most exposed situations and thrives on the coarser grasses and heather.

The Cheviots, which are found in the Border district and in Scotland are fairly long sheep with white faces and legs. The wool, which is fine and long, finishes behind the ears, the forehead being bare. Cheviots do best on grassy hills, but are very hardy and are strong rivals of the Blackface.

The Welsh Mountain—the name indicates the native haunt—is another very hardy breed. The rams have strong curved horns but the ewes are hornless; the faces and legs are either pure white or slightly dun-coloured.

The Black Welsh Mountain is somewhat similar in character, but carries black wool; the rather long body carries a short fine thick fleece.

Cross Bred Sheep.

In addition to the pure breeds there are a number of first crosses which are produced consistently and have acquired a reputation which is comparable with pure bred sheep. Two of the most popular of these first crosses are: the Border Leicester-Cheviot, commonly known as the Half-bred, and the Wensleydale-Black-face commonly known as the Masham. The ewes of these two crosses are very prolific and excellent mothers yielding lambs which fatten readily. They are produced in large numbers annually in Scotland and the North of England.

PIGS

Market Requirements.

The primary object of keeping pigs under war conditions has been to turn waste materials into meats. Quality has had no great significance, the main requirement has been for hardy animals which thrive under adverse conditions. It is an entirely different matter under normal conditions, for then quality has a considerable influence on the market value of a pig.

Normally pigs are kept for the production of pork and bacon. Both butchers and curers prefer a white pig or part coloured pig. A long pig with good hams, light in the fore-end, and well finished without being unduly fat, is required for bacon production. The requirements of the pork trade differ in different parts of the country. Smithfield market is the biggest meat market in the country; any class of pig can be sold there—at a price—and generally the highest price per stone is made by a good pig weighing 9 stone (72 lb.) dressed carcass. In the markets of the home counties, pigs which will yield a dressed carcass of 4–5 scores (80–120 lb.) usually make the best prices per score; while in the north country, 5–7 score pigs are readily purchased by

butchers. Some butchers like a long lean pig, that is to say, a miniature bacon pig, but others prefer a slightly thicker pig. Under normal conditions there is but little demand for very fat pigs either of pork or bacon weights, and such pigs can only be sold at a comparatively low price.

British Breeds of Pigs.

It will be convenient if these are dealt with in groups. First in order comes the Large White, or Large White Yorkshire, as the breed is sometimes called. This breed has gained popularity in every country where bacon pigs are kept. Few will challenge the statement that a typical Large White pig, if well fed, is the best bacon pig in the world. But in addition, pigs of this breed also hold a place on the pork market, for they are the ideal of those who favour the long, lean type of porker. The boars are prepotent sires and have been largely used for improving the breeds of other countries. The sows are prolific, a litter average of 9 pigs weaned is comparatively common, and the pigs grow rapidly if well done—a 7 score (Wiltshire bacon sized) pig can be produced in six months: but, and this point cannot be too strongly stressed, they must be well fed. Pigs of this breed will, when they are 2–3 years old, attain a very large size.

With the Large White may be grouped the Tamworth, a pig with a golden yellow coat, which has the reputation of being very hardy and of producing a very lean carcass. Also the Large White Ulster, a pig which in its own locality has gained a high reputation as a bacon pig. The first cross between sows of either of those two breeds and a Large White boar makes an extremely good bacon pig.

Then it will be convenient to group together a number of breeds which can be utilized in the same way, although they differ greatly in their characters. The Large Black, a black lop-eared animal was developed in the South Eastern Counties, and in the South-West. The Gloucester Old Spot, National Long Lop-eared pig, Cumberland, Middle White, Berkshire, the Saddleback with its characteristic black and white markings and its two branches—the Wessex and the Essex, may all be here included. Pigs of these breeds are readily purchased by local butchers in their own localities for the pork trade, but for the national market it is better to cross the sows with either a Large White or a Middle White boar. The Large White cross yields pigs which are good either for the bacon trade or for pork where the long, lean type of porker is favoured. The Middle White cross produces a pig suited for the pork trade where the broader type of porker is favoured.

All these breeds contain a number of good farmers' pigs, that is to say, hardy animals which are good grazers, economical feeders and good mothers.

Feeding

Some Underlying Principles.

During the grass season most farm stock, except pigs and poultry, obtain the major part of their rations from the pastures. In the depth of winter a large proportion of the cattle, horses and pigs are confined to the homesteads and are entirely hand-fed, while pastures are so bare that even those animals that are out on grass must be provided with the greater part of their food requirements. Between these two extremes the farm live stock obtain varying amounts of food from the pastures which must be supplemented with a certain amount of hand-feeding if the best results are to be obtained. The amount required depends upon the quantity of keep* provided by the pastures; this is governed by weather, soil and other conditions, and differs greatly from field to field and in a given field from year to year.

Early in May the pastures contain a comparatively small amount of grass of high feeding value. As the month advances conditions usually favour rapid growth and the quantity increases, the quality being still high, but the dry matter content is slightly reduced. If, as often happens towards the beginning of July, a dry spell occurs, the conditions are no longer conducive to rapid growth and as a consequence the stock are often able to graze the pastures bare; there is then a period in which the yield of grass is small, but, in that case the quality is comparatively high. When the autumn rains set in pasture plants grow rapidly and the fields contain a comparatively large amount of grass, but it has a high water content and a comparatively low food value; finally, as the autumn advances, growth gets slower and eventually it is reduced to a minimum with the result that the stock are able to graze the pastures bare.

There is no known method of determining the value of the food a grazing animal is obtaining from a pasture. This is a matter which the stock owner must judge by eye, and the returns obtained from grazing stock are to a great extent determined by the skill and judgment with which he regulates the grazing, and the supply of supplementary food.

An animal will not rest contentedly if its stomach is only partly filled, and it will not thrive if it is not contented. Upon the other hand the capacity of the stomach is limited and once it is filled the animal will refuse to eat until part of the contents of the stomach have been disposed of. Farm horses, cattle and sheep have capacious stomachs and when on full winter rations receive a portion of their ration in the form of coarse fodder, hay, straw or silage; but they cannot eat sufficient of such materials to provide them with the protein* and starch equivalent* they require. Bulky foods, therefore, must be supplemented by concentrated foods such as oats, barley, peas, beans, the oil cakes and other

industrial by-products. Also it is desirable in the case of cattle and sheep to include a certain amount of succulent fodder in the ration.

Feeding standards have been worked out for cattle, sheep and pigs as the result of research work, and from the wide range of foods available it is possible to compound a very large number of balanced rations* for all types of stock. The particular ration in use at any given time should be determined by the supply of home-grown foods available and the comparative prices, and supplies obtainable of purchased foods.

Rations for Dairy Cows.

It is convenient to consider the ration of a milking cow in two portions—the maintenance ration, i.e. the part which is required to maintain the cow, and the production ration—which provides the food materials required for milk production. The cow requires:—

·6 lb. protein equivalent* and
6½ lb. of starch equivalent
per 1,000 lb. live weight for maintenance, and—
·6 lb. protein equivalent and
2½ lb. starch equivalent

are required to enable the animal to produce a gallon of milk.

The value of the grass eaten depends upon the quality of the pasture from which it is obtained. Some pastures during the grass season will provide a cow with sufficient food for maintenance and the production of up to 4 gallons of milk a day. Others will only provide for the maintenance of the cow and the production of one, two or three gallons of milk. If a cow gives more than these quantities it must receive concentrates sufficient to provide for the additional milk. The following is an example of a production ration:—

1 part by weight beans,
2 parts by weight oats,
½ part by weight decorticated ground nut cake.
It is used at the rate of 3½ lb. per gallon.

As an example of a winter ration for an average Shorthorn cow (weighing 11 cwt.) the following may be cited:—

20 lb. good hay, plus
30 lb. kale per day. This would provide sufficient food for maintenance and the production of 1 gallon of milk. If used in conjunction with the production ration given in the preceding paragraph a cow would receive:—

20 lb. good hay, and
30 lb. kale per day, plus—

3½ lb. concentrates,	if giving 2 gal. milk
7 lb. concentrates,	if giving 3 gal. milk
10½ lb. concentrates,	if giving 4 gal. milk

The last is the maximum amount the cow would eat and convert efficiently, so that if a cow gave more than 4 gallons it would need a special ration. In that case a limited amount of specially selected hay (first class meadow hay) should be used, and the more highly concentrated of the concentrated foods should be employed; as in the following ration:—

16 lb. very good meadow hay,
30 lb. kale,
6 lb. decorticated ground nut cake,
2 lb. linseed cake, and
4 lb. flaked maize.

will provide the food constituents required to maintain an average Shorthorn cow and enable her to produce 6 gallons of milk.

A dry in-calf cow requires ·3 lb. of protein equivalent and 1 lb. of starch equivalent in addition to maintenance requirements. Many breeders feed their cows at this period entirely on hay, giving an average Shorthorn 20–30 lb. per day. The practice known as "steaming up" is followed by some who are working for high milk yields. Under this system, during the last three weeks before she is due to calve, a dry cow receives, in addition to hay, concentrates which contain the food constituents which would be required to produce 2 gallons of milk per day. A practice which has been widely advocated is to feed 6 lb. of Palm Kernel cake. It is claimed that cows and heifers, which are "steamed up" produce better udders, and give a large milk yield than do those which are kept on maintenance rations until they calve.

Rations for Fattening Beasts.

During the grass season a fattening beast will be kept on first class pasture which should provide it with sufficient food to enable it to fatten. During the winter, fattening cattle are usually fed on the produce of the arable land, and their ration will consist of the foods available; the proportions in which they are used are determined by the weather prevailing during the previous summer. Roots and straw generally form the basis of the ration, kale and cabbage are also useful when available. Swedes are usually grown for fattening cattle when soil and climate permit. A very common arrangement is to start the fattening period with kale or white turnips, and to finish on swedes. The following is an example of the daily ration for a 9–10 cwt. beast:

Swedes	84 lb.
Concentrates	4–8 lb.
Oat straw	*ad lib.*

The animal would eat about 12 lb. of oat straw. The concentrated mixture can be formed from such foods as are cheap—at the time of writing, 3 parts oats, 1 part beans would be suitable.

Upon such a ration the animal should increase in weight between 7 and 10 lb. per week. If hay is used instead of straw or the concentrates are used more liberally, 10–14 lb. increase per week can be obtained.

Calf Rearing.

There is no better method of rearing calves than that of allowing a cow to suckle them, but it is not always convenient or economical. A modern dairy cow gives a great deal more milk than a calf requires, and a method which is sometimes adopted—much to be recommended—is to keep one or two cows specially for calf rearing. They suckle several calves when in full milk, the number being reduced as the milk yield falls. A cow can be made to rear eight or ten calves in a lactation period.

The more common method is to hand-feed the calf, a process which calls for a considerable amount of skill and patience. The ideal method is to start with milk and to continue with that food until the calf is eating hay and concentrates but the quantity of milk used must be carefully regulated, for if large quantities are used the danger of scour* occurring—a constant danger until the calf is eating an appreciable quantity of hay and concentrates—is greatly increased. In some cases scour is caused by a minor digestive trouble, and can be checked by simple treatment, such as keeping the animal short of milk; but scour is also the symptom of more serious disorders which do not respond to such simple treatment and some are contagious.

A calf requires a gallon of milk per day immediately after birth, and the amount may with advantage be raised to 1½ gallons per day by the time the calf is a fortnight old. That amount should suffice. When the young animal is about a month old it will start eating a little hay and a small quantity of concentrates: a mixture of:—

5 parts by weight—crushed oats,
4 parts by weight—kibbled linseed cake and
1 part by weight—fish meal,

is ideal at this stage. As its appetite for hay and concentrates increases the amount of milk can be decreased, so that by the time the calf is six weeks old it is fed entirely on hay and concentrates; water should then be constantly at its disposal. Some use milk substitutes to replace part of the milk used under the above system, but there are many stock breeders who do not consider them to be economical if the long view be taken. Personally, I deprecate their use before the calf is a fortnight old.

By the time it is three months old the calf should be eating 3–6 lb. of hay and 2 lb. of concentrates per day, the quantities rising to 6–8 lb. of hay and 2–3 lb. of concentrates at 6 months old. If possible, during this period a small quantity of green food—lucerne, cut grass, cabbage or kale is given to the young animal, but roots are not as a rule included in the ration before it is six months old. A small quantity of roots can be used between the ages of 6 and 12 months, by the latter age the calf should be eating 10–12 lb. hay, 10–20 lb. of roots or the equivalent in green food, and 2–3 lb. concentrates. Good oat or barley straw is sometimes used instead of hay for stores between 6 and 12 months of age, but good breeders do not as a rule include straw in the ration of calves which are less than six months old.

Sheep Feeding.

The management of mountain sheep is a highly specialized business which will not be dealt with in detail here. Lowland flocks may be kept either on grass or arable land, but in recent years the extended use of temporary leys has tended to remove the differences between the two systems, as in many cases arable ewe flocks are now kept largely upon leys. The ewe flock does not require liberal feeding at the end of the summer, and at that period is often used as a follower to clear up pastures from which other stock have had the best grazing. When the time for turning the rams into the flock approaches the ewes are usually given more liberal treatment. This may be done by transferring them to better keep, or, if that is not available, by giving them a small allowance of concentrates—¼ lb. per head per day.

The practice of running the ewe flock on leys or permanent pastures during the autumn and winter months is rapidly gaining popularity. Where this course is followed the feeding is usually on the following lines. Except during very severe weather the ewes receive no supplementary* food until about a month before lambing—during bad weather they are usually given 1–2 lb. of hay or pea-straw per head per day. Three weeks or so before they are due to lamb they are given a supplementary ration.* This, for those lambing early in the new year (January or February) is ¼–½ lb. of concentrates, 1–2 lb. of hay or pea-straw per head per day, and a small allowance of kale or roots. After lambing the supplementary ration is increased to ½–1½ lb. concentrates, 1–2 lb. hay, and 10–16 lb. of mangels per head per day. In the case of ewes which lamb late in the spring, ¼–½ lb. of concentrates per head per day will usually suffice during the month before lambing. This is increased to ½–1 lb. of concentrates and 6–10 lb. of roots per head per day after lambing. The lambs are encouraged to eat as early as possible, and in addition to what they take from their dam's allowance of hay and roots, receive behind a lamb creep as much concentrates as they will eat, up to ½ lb. per head per day.

Sheep are fattened during the summer on pasture without supplementary food unless dry weather intervenes. During the autumn and winter they are generally folded on roots or kale. A common practice is to grow white or yellow

turnips for the early autumn and swedes for the period from mid-November onwards. The type of ration fed is:—

1–2 lb. of hay or pea-straw,
8–16 lb. of roots and
¼–1 lb. of concentrates

(such as a mixture of 3 parts by weight oats, and 1 part beans) per head per day.

Rations for Pigs.

Pigs require a comparatively concentrated diet and under normal conditions roughage is only used as a supplement. The main portion of the rations consists of concentrates; weatings and barley meal are the basic pig foods, but they must be supplemented with some protein-rich food—soya-bean meal, fish meal and meat meal being those most commonly used. Green forage can replace up to two-thirds of the ration of an in-pig sow, and half that of a nursing sow. Green forage does not form an appreciable portion of the ration of a young growing pig, in point of fact, young stores out on grass or other forage crop will eat quite as much meal as their indoor mates, but the former grow more rapidly than the latter.

During the gestation period the amount of food fed is:—5–6 lb. per head per day of a ration containing 14–15 per cent of protein. A popular sow ration is:—

45% barley meal,
45% weatings,
10% fish meal.

The sow also receives a small allowance of green food or roots (6–10 lb. per day). The same type of ration is usually employed after farrowing when for the first three days the quantity of food is not increased; after the third day the amount is increased in such a way that the maximum daily ration is fed by the time the young pigs are fourteen days old. A standard adopted by many breeders is 2 lb. for the sow, plus 1 lb. for each pig in the litter up to a maximum of 14 lb. per sow per day—the minimum for any sow ration being 6 lb. per head per day.

The feeding of the suckling pigs is a matter of considerable importance. Piglings which can go out onto pasture with their dams, very quickly learn to eat, and it is a good plan to feed them behind a creep and let them have all the food they will eat; some of them will start to show an interest in food when between 2 and 3 weeks old. Piglings which are confined to indoor pens are liable to be rather more troublesome in this respect. The fact is that such piglings are liable to become anæmic, and piglings which suffer from this disorder will not develop a normal appetite, and are very difficult to rear. This can be avoided by placing at their disposal a dilute solution of Parrish's food. One dram per pig in a small amount of water will suffice. This is given to them daily when they are 2–6 weeks old. Piglings receive some very simple food in the first instance, such as a mixture of equal parts of barley-meal and sharps. They will usually start to eat dry food a fortnight or so before they will eat soaked meal. When they are eating an appreciable quantity of food they can be given a mixture like the one suggested for sows.

A similar mixture is fed after weaning. The weaners, if intended for bacon, are given all the meal they will clear up readily twice a day until they are about 100 lb. live weight, when they are usually eating 4–4½ lb. per head per day; at that stage they are put onto a ration containing a higher proportion of barley meal, such as:—

60% barley meal,
30% weatings,
10% soya bean meal, plus
1½ lb. chalk, and ½ lb. salt for each 100 lb. of mixed meal. There are two systems of feeding from 100 lb. live weight onwards. Some feeders give the pigs all they will clear up twice daily—they will usually eat 6 lb. at 150 lb. live weight, and 7 lb. at 200 lb. live weight. Pigs fed in this way are liable to be slightly too fat. A somewhat leaner pig is produced by restricting the ration—under this system the ration reaches 5 lb. per head per day when the pig is 140 lb. live weight, which is the maximum amount used by some feeders, while others make their maximum 6 lb. per head per day, which is reached when the pig is 180 lb. live weight.

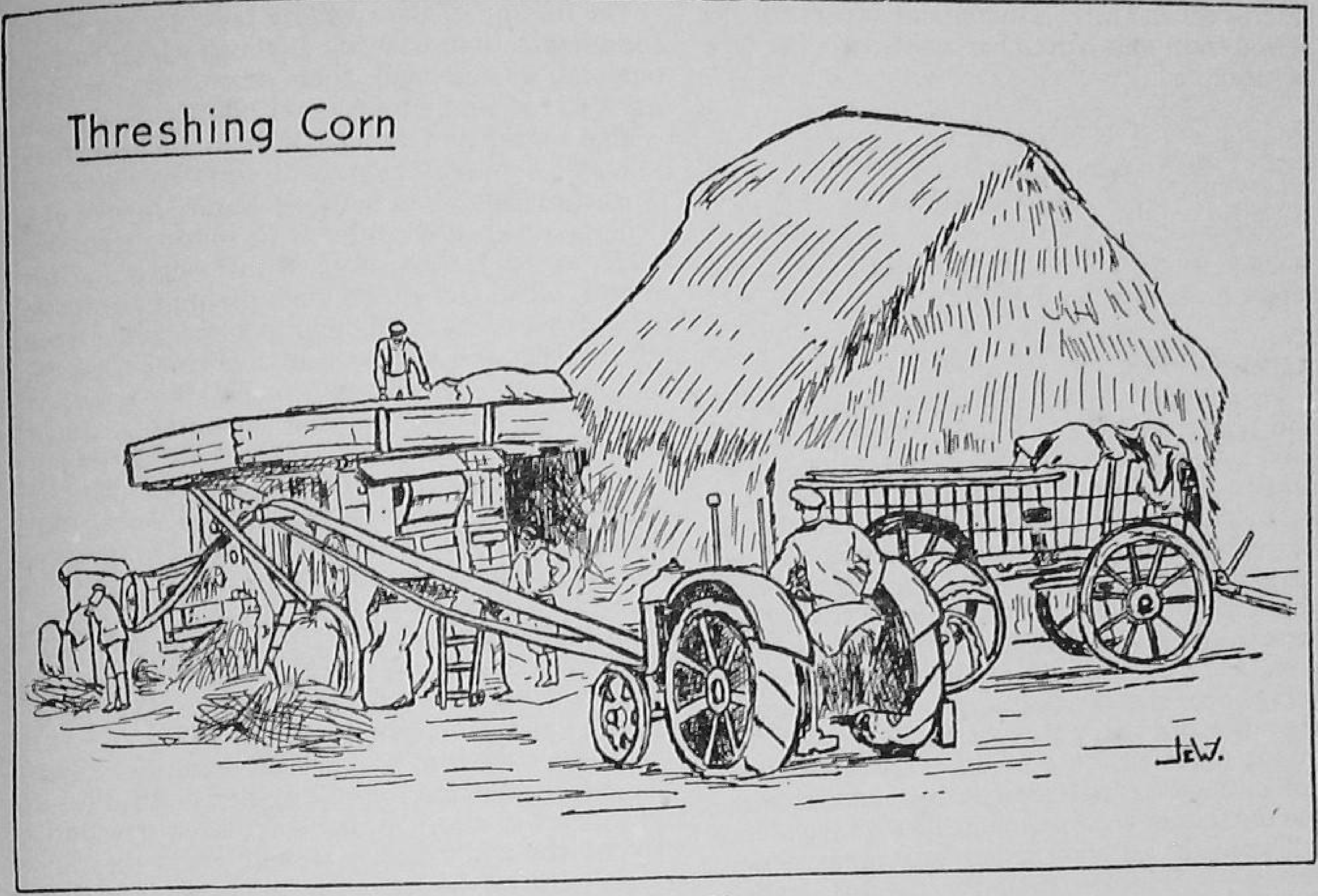


FIG. 20

SYSTEMS OF MANAGEMENT

The way crops and stock fit into the economy of the farm is now explained—Basic principles. Influence of:—Market prospects, soil and climate, labour, water supply. Need for economy and efficiency. Advantages of general farming. Dairy farming: disease control, whole milk, butter and cheese production, the bale system. Beef production on grass and arable land. Sheep, grazing and arable flocks. Pigs: farm pigs, specialized pig farms, methods of management. Poultry farm units and specialized poultry farms.

BASIC PRINCIPLES

CAREFUL planning is an outstanding pre-requisite to success in farming. The farmer is constantly working for the future. With crops, at least twelve months elapse between the period at which work is commenced upon a seed bed and the harvesting of the crop. With stock, two or three years must pass, at times, before a breeder begins to reap the benefit of an action. For instance, it is nearly twelve months between the date on which a new bull is imported into a herd and the birth of his first calf, while 3½–4 years must elapse before the first of his offspring produces its first milk.

The system of farming practised on many farms is the result of the experience of many years, and is designed to make the best use of the land. But on others the system followed has been adopted because it is considered the most profitable in spite of the fact that it is not suited to that particular farm; an example of this is to be found in the vicinity of large urban centres where milk sells so well that cows can often be profitably kept on farms which are far from desirable for the purpose.

The system of management followed on a farm should be determined by five main considerations:—(1) market prospects, (2) the soil and climate, (3) the water supply, (4) the labour supply, (5) economy and efficiency in management.

Market Prospects.

The price obtainable for farm produce is an overriding consideration in farming. Farmers have little if any control over prices, for these are governed by world markets and political considerations, both of which are liable to cause price fluctuations. Farmers can only watch prices and try and judge future prospects, adapting their methods of farming to meet market conditions.

Soil and Climate.

As regards soil, most crops can be grown on free working loams of average depth. Market-garden crops: potatoes, peas, barley and turnips are the principal crops of light land. On this type of soil sheep folding* is frequently a feature of arable farming. On heavy land, wheat, beans and mangolds do well, while vetches and clover

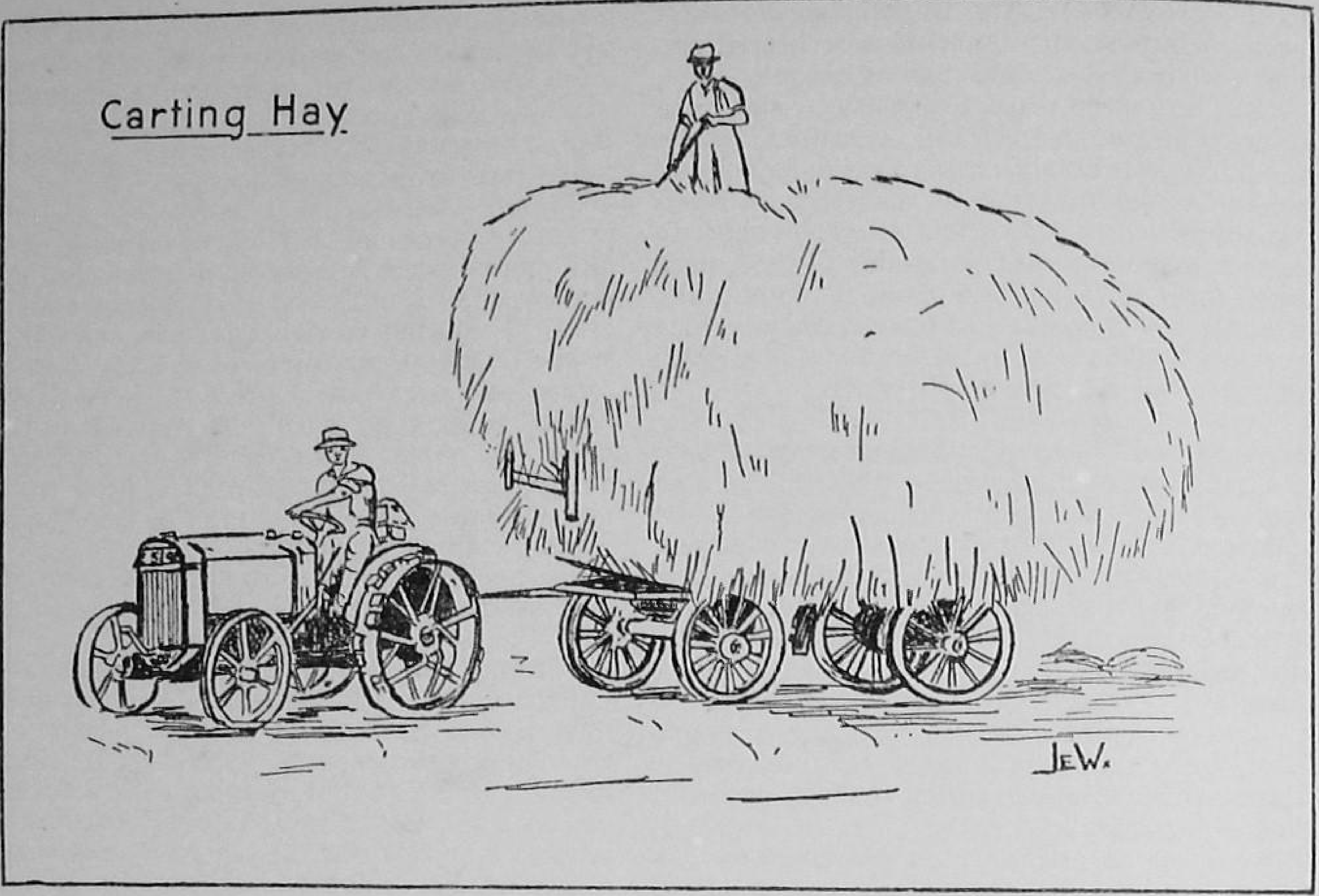


FIG. 21

will crop well if the land is drained and supplied with lime. Sheep cannot be folded on heavy land during the autumn and winter.

Oats, swedes and potatoes do well in a moist climate. Barley needs a fair amount of moisture in the early stages of growth, but dry weather is desirable at harvest if a malting sample is to be grown. Leguminous crops respond to moist conditions during growth, but fine weather is desirable after cutting if these are to be made into hay.

Pastures need a deep soil and are seen to the best advantage under moist conditions. Some of the best pastures are to be found on water meadows. In a dry climate a good permanent pasture can only be maintained upon a soil which has considerable power of resisting drought. During the winter and spring when the land is wet, pastures on heavy land are liable to get badly trodden if cattle are allowed upon them. Partly for this reason it is customary to confine cattle to the homestead during that period. Upon the other hand, on light land in a reasonably mild climate, cattle are frequently "wintered out."

The poor thin soil of mountains and the higher hills carry a thin herbage in a climate which is liable to be very severe. Under such conditions only hardy breeds of livestock such as West Highland, Galloway and Welsh Cattle and Blackfaced Mountain, Cheviot and Welsh sheep can maintain themselves.

Water Supply.

The presence or absence of drinking water in fields determines the extent to which land can be used for grazing cattle. Sheep need less water than cattle and it is possible to graze them on enclosures which do not contain watering places. But even so a considerable amount of water must be carted to them during the summer months.

Crops which need spraying can only be cultivated on land which has an adequate water supply.

Labour.

The more intensive methods of farming involve the employment of a comparatively large staff, and can only be carried out in districts which have an adequate supply of labour; that in turn is governed very largely by housing facilities.

A second aspect of the labour question is that quality is as important as quantity. Nearly all important farm work, and many of the minor jobs, can only be carried out efficiently by skilled workers. Results obtained from a simple test illustrate this point. A group of weanyer pigs was taken and divided into four pens, which were as nearly as possible alike in all respects. Two were fed by a skilled herdsman, the two comparable pens by an enthusiastic amateur. Both men used exactly the same rations from the same bin. At the end of the two months' feeding, the two pens fed by the herdsman made top prices at the

local show and sale, two of the pigs winning a prize. The amateur completely upset his pigs and they were not ready until three weeks later.

Of course an intelligent man can in time learn to perform most agricultural operations. But it should be added that to make a good agricultural worker, a man must have an interest in his work. Skill alone is not sufficient. As a consequence a regular man is almost invariably a very much better farm hand than is a casual labourer. For this reason a system of management which provides regular work is preferable to one which provides only seasonal employment.

Economy and Efficiency in Management.

If maximum efficiency is to be combined with economy it is essential that crops should be cultivated efficiently and stock well managed. They must be combined with efficiency and economy in the utilization of labour, manure and farm by-products. The best results are usually attained by a combination of arable land and livestock. Livestock is necessary to make use of some of the unsaleable by-products of arable land; arable crops are desirable because some of them utilize the manure from stock much better than will pasture.

As far as arable crops are concerned, over a period of years, a suitable sequence of crops will utilize the plant food in the soil more efficiently than will one crop grown continuously. Crops like potatoes and roots receive very thorough cultivation, so that when they grow, weeds receive a set back, and at the same time the mechanical condition* of the soil is improved. Weeds tend to accumulate and the mechanical condition of the soil deteriorates when land is carrying winter corn. By alternating these two types of crop the soil can be kept clean and in good mechanical condition with the minimum amount of labour.

If labour is to be utilized economically the work of the farm must be spread out as evenly as possible over the year. This reduces to a minimum the number of days on which machines and horses are idle and men are engaged on non-productive work. It can be achieved by growing a number of crops which are sown and harvested at different periods of the year.

Another point: labour, and what are equally important, time and effort, can be saved by growing crops on suitable land—some crops leave the land in an ideal condition for another crop. The most notable instance occurs in connection with winter corn. There is always a great deal to be done on the farm during the winter months and it is all important that the seed beds for winter corn should be prepared on land that can be worked down quickly and with the minimum effort. Land which has carried peas and has had a short bastard fallow* is ready to crop; land that has carried beans, which have been well hoed, or potatoes, is clean and in good mechanical condition, and from it a seed bed can be quickly and easily prepared. All these crops leave the land rich in nitrogen, a substance which is very important to winter corn. For these two reasons, winter corn can with advantage follow peas, beans and potatoes.

Turning next to the question of efficient utilization of manure. F.Y.M. is most economically utilized when it is spread and ploughed in quickly, it is obviously best to use it for an arable crop. Then some crops like potatoes and roots respond to heavy dressings of F.Y.M. supplemented by artificials, but F.Y.M. is best not applied to land on which winter corn is to be sown, but winter corn requires soil rich in nitrogenous residue; on the other hand high quality malting barley is produced on land which is not excessively rich in nitrogen.

The advantage of growing a succession of crops such as potatoes, wheat or barley on a field is obvious.

Rarely, if ever, is the practice of burning straw justifiable. Far more economical is the course followed on most farms in this country of consuming part of the straw as food and treading the rest into F.Y.M. Stock also provide a means of converting into a saleable form, certain unsaleable materials such as tail corn* and chat potatoes.* But as pointed out elsewhere (p. 42), it is desirable to provide them with succulent fodder as well; roots, kale and cabbage being usually grown for that purpose.

There is no aspect of British farming which draws more comment from our visitors from overseas than the diversity of the output from our farms. It will be seen from the preceding paragraphs that this diversity of interests, far from being a weakness, is sound business, for it makes it possible to secure the maximum amount of economy and efficiency in management. Here it may not be out of place to reiterate the statement made in the preface, viz.: that conditions differ so much from farm to farm that no statement can be made which will be true for all farms. For though on a very large proportion of the farms of this country it is an advantage to grow a variety of crops and to keep livestock, there are a few holdings upon which specialization is fully justified.

Dairy Farming.

Dairy farming may be regarded as the most important branch of farming. Practised in all parts of the country, it can be carried out on mixed, all-grass or arable farms. Whole milk is much the most important product, but small quantities of butter and appreciable quantities of cheese are also produced.

Diseases, of which tuberculosis, abortion, Johné's disease, sterility, and mastitis are the most common, are a constant menace to a dairy herd; so much so that measures designed to control such disorders are carried out as part of

the routine practice in many up-to-date herds. Tuberculosis is controlled through the Attested Herds Scheme of the Ministry, by the tuberculin-testing of dairy cattle under the Milk Special Designations Order and also to some extent by the Tuberculosis Order. In 1942 the National Farmers' Union, the National Veterinary Medical Association, and the Ministry of Agriculture prepared a scheme designed to encourage and facilitate the better control of abortion, Johné's disease, sterility and mastitis; as the result of research in recent years effective methods for their control are now available; the essence of the scheme consists of an undertaking between the farmer and his veterinary surgeon in which each will play his part in carrying out the approved methods of control; in every case where such an undertaking is entered into, the Ministry of Agriculture will provide free laboratory services for such diagnostic work as may be necessary, abortion vaccine free of cost, sulphanilamide at a greatly reduced charge.

The National Veterinary Medical Association has agreed to a scale of fees for veterinary surgeons working under the scheme which should be well within the reach of the average farmer, and which should prove a profitable investment for any farmer who suffers appreciable losses from the ravages of one or more of the diseases named. In this way farmers can obtain a comprehensive service for the control of the diseases in question considerably cheaper than would otherwise be able to do.

This scheme could with advantage be made of general application. Any herd in which disease is allowed to develop or smoulder uncontrolled is a plague spot from which trouble is liable to spread to neighbouring clean herds.

On some dairy farms the herd is home bred. A good dairy bull is kept and sufficient heifers are reared to replace herd wastages; in some cases all the heifer calves are reared, the surplus heifers being sold either as bulling* heifers or in-calf. This must be regarded as the soundest method of herd management, because when it is followed it is possible to grade up the herd; also the risk of importing disease—a very serious risk in the case of dairy cattle—is reduced to a minimum. Grading up a dairy herd is a slow and tedious business—beset with many disappointments—which can only be done effectively by those who can follow their stock through several generations. Those who do so, however, can gradually improve not only the average milk yield of their cows, but also their appearance and conformation.

It is either not possible or inconvenient to rear young stock on some dairy farms. In such cases the herd is maintained by buying either bulling or in-calf heifers or freshly calved cows in their prime. Heifers have the advantage that they have a comparatively long life before them, and with them the charge for depreciation per annum is comparatively small, but there can never be any guarantee that a heifer of unknown origin will prove to be a good milker. However, where there is a demand for any type of animal, it is invariably met, and there are farmers who make it their business to breed good class dairy heifers, and by buying from such men the risk of getting an unduly large proportion of bad milkers or unthrifty animals can be reduced to reasonable limits. As an instance of what is done in the matter of heifer production may be cited a farmer who had a contract to take all the surplus heifer calves from three cheese-making farms on which a good class of cow was kept; the agreement being that a good dairy bull should be used as sire. He was producing from 60 to 70 really good type dairy heifers a year, which he offered for sale in-calf in the early autumn.

There is a very good trade in the dairy farming districts for first-class freshly calved cows in their prime, cows which have recently calved their 3rd or 4th calf and usually come down with a really good udder that gives the promise of a heavy lactation period; they have produced a large amount of milk for the herd in which they were bred, and if sold at this stage will realise a price that more than covers production costs, so that no charge for depreciation is incurred. Thus it is an attractive market for dairy farmers to fill. The cows are ultimately purchased by dairymen adjoining large urban centres who concentrate on producing the maximum yield per cow. In many cases the cows which are not stocked are well fed and are sold fat when they become dry. Under this system the maximum yield of milk per acre is produced—and that is the main consideration with a large proportion of the dairymen adjoining urban areas—but depreciation charges are high, and fundamentally it is wasteful of good animals.

Where whole milk or butter is the product, cows must calve all the year round. There is always a tendency for cows to raise their yield when the grass grows rapidly in early May, and the flush is normally maintained until mid-June; therefore it is not necessary to have any cows calving during this period. Cows should calve at fairly regular intervals throughout the remainder of the year with a preponderance in October, November and December, which is the period when it is most difficult to maintain the milk yield. A considerable amount of skill and judgment is required to ensure the production of a level milk yield throughout the year, and that is necessary to secure, under normal conditions, the maximum price per gallon. Milk recording was not instituted for the purpose but records are very helpful when working out the calvings for the year. Other things being equal July and August calvers are the least efficient yielders.

The management of a cheese-making herd is a comparatively simple business, because cheese is only made during the summer months. All the cows calve down between mid-March and the end

Fattening Cattle in Yards

FIG. 22.

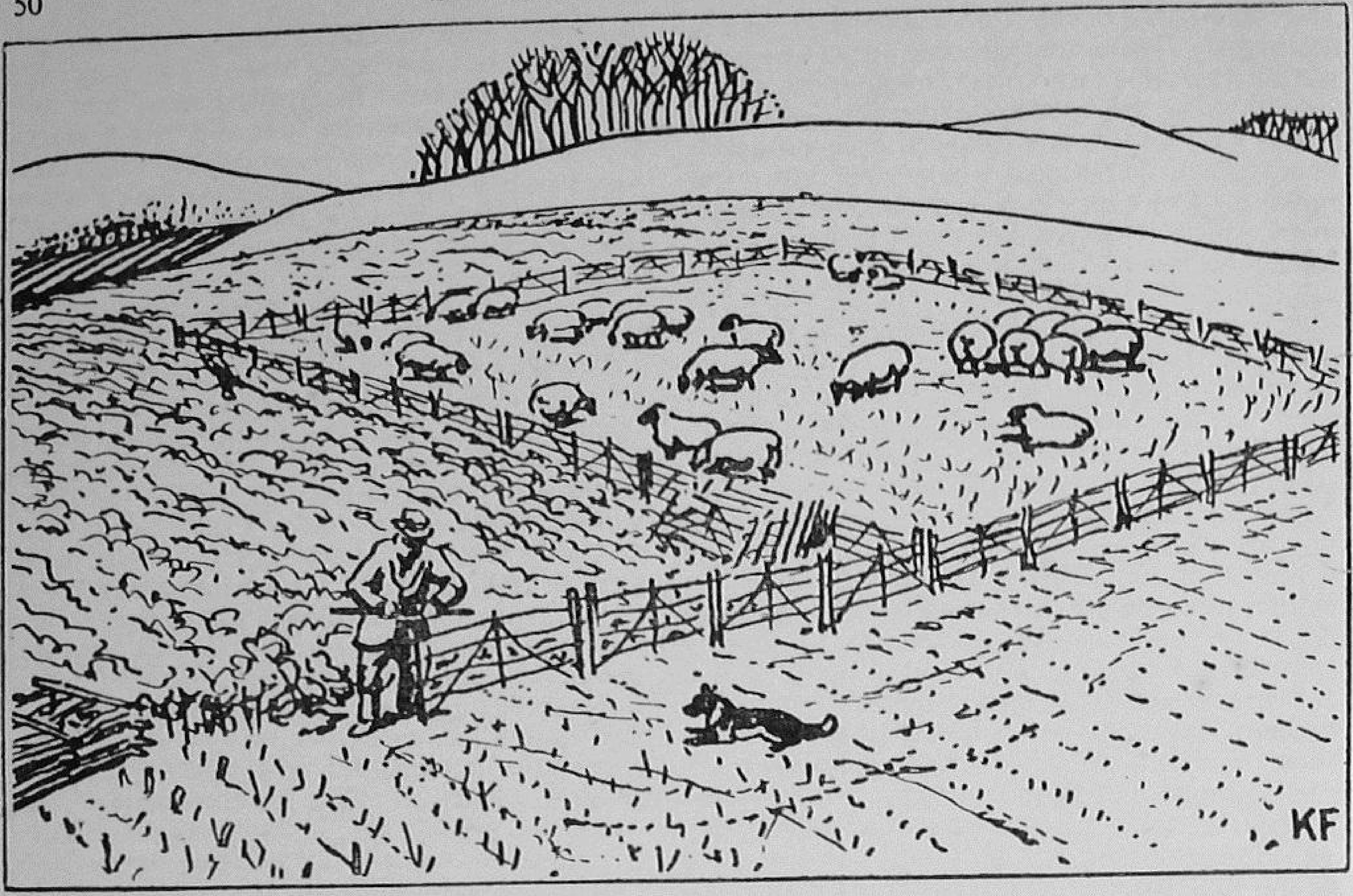
of April, and they are grass-fed during the main part of their lactation period. Milk usually sells well during the autumn months and there is no difficulty in disposing of the small amount produced at that period of the year when cheese is not generally made. During the winter and early spring the cows are dry.

Reference should here be made to what is generally known as the Hosier or bale system of keeping cows. Under this system cows are kept on outlying pastures or leys. They are milked in a portable milking shed provided with a milking machine. The shed is erected at a convenient spot and moved on to fresh ground every two or three days. The cows lie out day and night, being brought in for milking and receive their allowance of concentrates while being milked. This system is notable in that it provides an efficient method of managing outlying fields; it is an expensive matter carting F.Y.M. to outlying land, and under the Hosier system this is avoided, as during the period of grazing the whole of the excreta is dropped direct on the land.

Beef Production.

The fattening of cattle is still an important business, for although beef prices before the war left little, if any, profit on yard feeding, the manure the animals produced was required on many farms to maintain the fertility of the soil. Fat cattle are sold either as veal, baby beef* or mature beef. The demand for whole milk greatly reduced the amount available for stock food and before the war, veal was mainly produced during the summer months when milk was plentiful, and surplus milk difficult to sell. Baby beef is obtained by forcing the animals so that they grow and fatten at the same time: they are ready for market when between 10 and 18 months old and their carcasses are super-grade. Before the war they sold well at comparatively high prices. For that reason the production of this type of animal was expanding rapidly. None the less, the main supply of beef coming on to the market (before the war) was in the form of two-year-old animals—usually referred to as mature, though of course a beef animal is not fully grown until it is over three years old. The quality of the meat produced at two years old is better than that from a similar animal at three years, also the joints of the younger animals are the more suited to present day taste.

Mature beef is fattened either on high grade pastures during the summer, or in yards during the autumn and winter months. The highest grade fat beasts are produced from animals of beef type. These are usually born in the summer and run with their dams on the pastures, being weaned and transferred to yards for their first winter. During the second summer they are grazed, the second winter being either spent on pasture or in yards according to the facilities



Folding Sheep

FIG. 23.

available. Animals born in the late spring or early summer, if well done throughout their life, should have made sufficient growth to be turned out onto fattening pastures to finish at two years old. Those which are born later in the summer are usually finished in yards during the autumn and winter at 2–2½ years old.

Owing to the unattractive prices paid for home-fed beef before the war, there was a clearly marked tendency for beef cattle to give place to dairying; a change that the war has encouraged. But only a small proportion of the dairy cattle reared are required for breeding purposes; the surplus heifers and all the steers are available for fattening. Some of these will only yield second grade carcasses, but the majority, while not being quite so good as those from beef type cattle, can be classed as high grade if they are kept growing from birth and fed well. They are finished on fattening pastures or in yards when 2–2½ years old.

Beef cattle are reared and fattened on some farms, but in many cases fattening pastures are to be found on farms which are not suitable for rearing, while winter fattening is mainly carried out on arable farms which cannot accommodate either breeding or store stock. As a consequence a very considerable trade has been built up in the production of store cattle;* large numbers of two-year-old stores are offered twice yearly. Sales are held in the spring at which beasts can be purchased for finishing on the fattening pastures, and again in the late summer for those who require animals for yard fattening. This trade which is the growth of years enables the best use to be made of available facilities.

Sheep.

There are two main systems of sheep management. In what will be referred to as grazing flocks, the sheep are kept on pastures; arable flocks are on arable land, being folded upon forage crops which are arranged to provide a succession of keep throughout the year. Also the two systems are intermingled, the sheep spending part of the year on pastures and the remainder on arable crops. Some grazing flocks lamb in the fields, others are brought into yards which are either permanent or temporary. In arable flocks lambing usually takes place in temporary yards which are generally erected close to straw stacks to provide protection.

Early lambs are sold at Easter, and under normal conditions for the first few weeks of the lamb season realize a comparatively high price. The early lamb trade is catered for by some breeders in the milder parts of the country. Ewes of an early maturing breed are lambed late in December or early in January; they are liberally fed, often being folded on kale, and receive 1–1½ lb. of concentrates per head per day. The lambs are also encouraged to eat concentrates.

The majority of flocks lamb in February, March and April. There are still some flocks which are put on to arable crops after lambing, but within recent years the practice of grazing ewes and lambs has been widely followed even on arable farms where the sheep are now often given free range on temporary leys, a method of management which saves the labour of erecting sheep folds: this has to be done every day if the sheep are folded.

After reserving the lambs required for breeding purposes from the lamb crop the remainder are fattened. Some of the more forward lambs are sold fat off their dams during the summer. Weaning of the remainder takes place in July and August. After weaning the lambs become tegs. A very large number of tegs is folded and fattened on turnips and swedes during the autumn and winter months; others are kept through the winter, in most cases on grassland, to be fattened on fattening pastures during the following summer.

Breeding and fattening are frequently done on different farms. The stores* change hands at sheep sales held annually in the late summer and early autumn, and in the spring.

Shearing takes place towards the end of May or at the beginning of June. In the case of some of the long-woolled sheep, lambs are shorn, but most are not shorn until a year old; subsequently they are shorn each year. It is customary in some flocks to wash the sheep 7–10 days prior to shearing.

During the warm weather a ceaseless watch must be kept for damage from the sheep maggot fly—sheep should be inspected every day. The fly lays its eggs on the wool; the maggots hatch out, break the skin, burrow into and feed on the flesh. An affected sheep gets into an appalling condition unless quickly dealt with. The maggots must be destroyed and the wound dressed with a lotion which will help the skin to heal and keep the fly away.

Round worms are liable seriously to reduce the condition of sheep, especially lambs which are kept on pastures that have been previously heavily stocked with sheep. On some farms the lambs are dosed with a vermifuge as routine practice. Upon wet land fluke, causing liver rot, is liable to be troublesome. This pest, which is most liable to occur in the autumn, is most troublesome in wet seasons. There are two methods of control. The flukes have an intermediate host—a snail that inhabits wet meadows —no snail, no fluke. Therefore, the fluke is decreased by spraying infected land with ½ per cent copper sulphate solution at the rate of 137 gallons per acre, or dusting it with powdered copper sulphate (28 lb. mixed with 1–2 cwt. of sand per acre), as this kills the snails. Sheep which are attacked by this pest can be cured by administering carbon tetrachloride capsules.

Sheep Dipping Orders, which were formulated to control scab, lay down that in England all sheep must be dipped once between 14th July and the 1st September. In Scotland they must be dipped twice between 1st June and 31st August, and between 1st September and 12th November. Also in scheduled areas the double dipping order is in force, and here the sheep must be dipped twice at intervals of not less than 7 nor more than 14 days.

Pigs.

The pigs may be kept either as a unit on a general farm or as the sole business of a specialized pig farm. Pigs fit into the scheme of a general farm very well; there, they can be a useful and profitable department, for not only will they consume by-products such as tail corn and chat potatoes, but will produce a large amount of high quality F.Y.M. Specialized pig farms are liable to be a snare for the unwary. At times profits from pigs are attractive, the turnover is quicker than with most branches of farming, the capital involved is comparatively small, and it is often an easy matter to acquire the small area required for a pig farm. But pig prices are liable to fall to an uneconomic level. Moreover, pigs are susceptible to several destructive diseases—swine fever, swine erysipelas, and foot-and-mouth—and their incidence may easily destroy all prospects of a profit for a year or more. Thus the specialized pig farm must be regarded as a gamble, though where cheap food such as swill is obtainable, it may be a good gamble.

Pigs may either be kept indoors, i.e. confined to buildings (usually called sties), or out-of-doors. In the latter case they may have free range over grassland, woods or waste land, or be confined to temporary pens or tethered. The value of outdoor pig-keeping lies partly in the better health of out-door pigs, and partly in that they collect forage; the method is most valuable in the case of breeding stock and young pigs, and of comparatively little value for fattening stock.

A very common system is to keep both gilts which are being reared for breeding and in-pig sows out of doors, allowing them free range, and to confine nursing sows and their litters and fattening pigs to indoor pens. Nursing sows and their litters are sometimes kept out of doors, but this can only be done successfully on reasonably dry land free from the eggs of parasitic worms.

Ducks, Geese, Turkey and Poultry.

A unit of hens is found upon most general farms and there is a very large number of specialized poultry farms in the country; in addition, ducks, geese, and turkeys are kept on some holdings.

Geese and turkeys, notable for their place in Christmas fare, are kept to a very limited extent. The former are excellent grazers and will forage for most of their food. Turkeys are delicate in

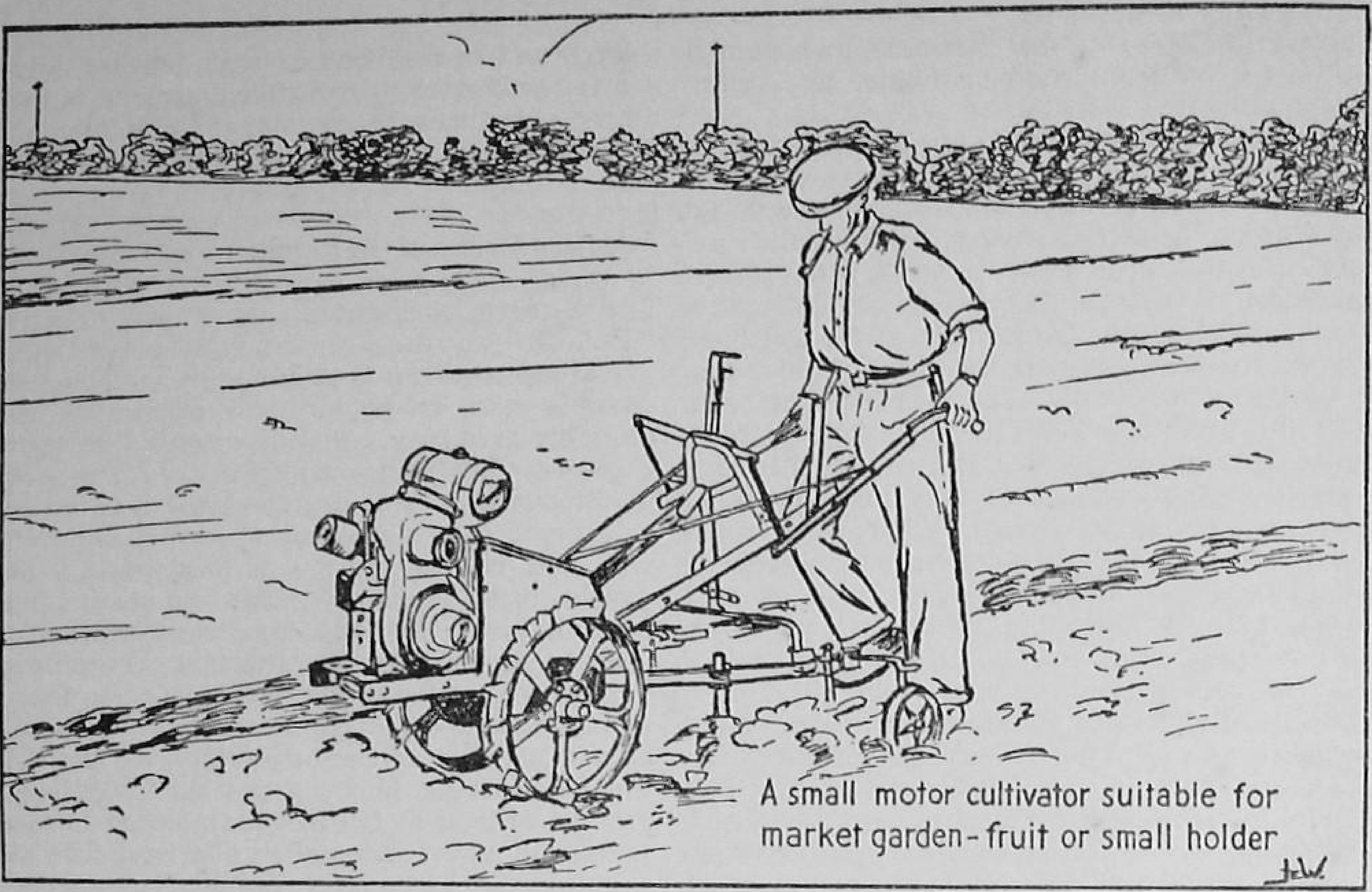


FIG. 24.

the early stages and difficult to rear, but become more robust after they are two months old.

Ducks, with the exception of runners, can with advantage be given access to swimming water if kept for egg production, but must not be allowed to go into water while being fattened for the table. On the farm, ducks are generally kept for egg production. Rearing and fattening ducklings for table purposes is a branch of the industry that is most frequently found on small holdings. It is regarded as a highly skilled specialized business.

Egg production is generally the primary object in keeping poultry on general farms. Surplus cockerels are often sold in a store condition, if fattened on the farm they are usually treated in the simplest possible manner.

On many general farms the poultry unit is small and the equipment simple. Eggs are "set" under a hen which is allowed to mother the chickens until they are large enough to fend for themselves. When old enough to perch they are allowed into the hen house. The hens, which have free range, pick up an appreciable part of their living.

On other farms comparatively large units are kept, in some cases the chickens are reared under hens, but frequently the eggs are hatched in an incubator, the chickens being reared in a foster mother (hover), from which they are transferred to small runs on clean grass land at eight weeks old.

Three alternative methods are employed for keeping hens on general farms. The simplest and the most healthy is to house them in portable huts and allow them free range over pasture which is grazed by other stock, the fowls being thin on the ground (not more than 50 to the acre). A second alternative is to allocate a field to the fowls, running 100–150 per acre. In this case 100–150 birds form a convenient unit—for, though it is possible to house very much larger units, there is a loss of efficiency in units of over 150 birds. The third alternative is the fold system, under which the birds are kept in portable houses and runs, which together measure 20 ft. × 5 ft. and accommodate 25 birds. These are moved their own length on to clean ground at intervals of one or two days, so that the manure gets distributed over a very wide area. Properly managed poultry can play an important part in land improvement.

Before the 1939–45 war there was a very large number of poultry farms in the country, and the number was steadily increasing in spite of the fact that if due allowance were made for depreciation of plant the margin of profit was very small. The specialized poultry farm is essentially a case of "all the eggs being in one basket," and for that reason must be regarded as being a precarious business. Many poultry farms were designed for commercial egg production; in so far as there is always a market for fresh eggs this branch of the industry is on a firm foundation, but unfortunately it is a market which can be saturated, and when this happens prices are unremunerative. The table poultry industry is firmly established in some parts of the country, and there is also a

steady demand for good breeding stock, though this is a market upon which there is a clearly defined limit.

A considerable amount of skill, attention to detail, and cleanliness are essential to success in specialized poultry-keeping. Two systems are practised: the semi-intensive, in which the birds are kept in houses to which small wire runs are attached, 200–300 birds being accommodated per acre; and the intensive system, under which the birds are kept confined in somewhat elaborate houses. The semi-intensive system is the better for the production of breeding stock. Here it may be pointed out that fresh land, that is to say, land on which poultry have not been run for several years, is desirable for young birds—there are instances where the pens carrying older birds have been for many years on the same ground, but, even for them, an occasional change of ground appears desirable.

High production has also been attained by keeping the birds in batteries of laying cages, which reduces poultry-keeping almost to a factory system.

Taking a long view the best system is that which gives the birds the surroundings most nearly natural. Stamina is maintained at a high level, and disease kept at bay. Higher output may be obtained by specialized methods, but this may sometimes be more than off-set by high death rates and general deterioration of constitution.

Market Gardening and Fruit.

Some holdings are devoted entirely to garden produce, on others fruit is the primary objective. Both fit into the organization of general farms in districts where conditions are suitable, and find a place in the economy of many. Both market gardening and fruit-growing are highly specialized industries, both are very complex and characterized by their diversity. Between the man who cultivates an allotment by hand in his spare time, and sells his surplus produce, and highly organized farms upon which highly skilled labour and the most improved mechanical devices and storage accommodation are utilized, a wide range of varying systems is to be found. Both these branches of the industry were slowly extending their sphere before the war, and their rapid growth is likely in the future, because the results of modern research have tended to focus attention upon the importance of fresh fruit and vegetables.

SOME REPRESENTATIVE FARMS

The way crops and stock fit into the economy of the farm is demonstrated by a number of farms described during the 1939–45 War by well known agriculturists:—

An East Lothian farm
Wm. Bruce, M.A., B.Sc.
A West of Scotland Mixed farm
John Kirkwood, B.Sc., N.D.A.
A Welsh farm
Professor E. J. Roberts, M.A., M.Sc.
A Northern Ireland farm
Robert Hale, B.Sc.
A Wiltshire Arable Sheep farm
W. T. Price, M.C., B.Sc., N.D.A.
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A Small Lancashire Arable farm
J. J. Green, B.Sc.
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H. I. Moore, M.Sc., Ph.D., N.D.A.
A Herefordshire Fattening farm
J. Ll. Evans, B.Sc., & C. Kinsey.
A Poultry farm
Adrian T. Monck-Mason
A Pig farm
The Author.

The best method of gaining a knowledge of farm management is to study a number of farms. It would be necessary to examine a very large number to obtain a complete picture of British farming. But a general impression of the methods employed can be obtained from the fourteen farms described in this section. They are situated in different parts of the country, and are good examples of a few of the more important types of farming.

AN EAST LOTHIAN FARM

BY

WM. BRUCE, M.A., B.Sc.

THIS farm is situated on the Southern shore of the Firth of Forth, about 11 miles from Edinburgh and Leith, gently sloping from an elevation of twenty feet up to a hundred feet. The soil varies from sandy loam next the seashore to fairly heavy loam. The farm extends to about 300 acres. It is owner-occupied and the annual value is 50/- per acre. The farm specializes in the production of malting barley, potatoes, bacon pigs, and poultry and eggs.

Although East Lothian gives its name to the six-course rotation—oats, potatoes, wheat, roots, barley, and hay, in practice many farmers specialize in certain products and evolve rotations to meet the circumstances. Here three rotations are followed on different parts of the farm according to soil. On the heavier land (1) wheat, (2) barley, (3) potatoes (late); on the medium land (1) barley, (2) potatoes (early and late), (3) barley, (4) sugar beet; and on the light land (1) potatoes (early), (2) grass, partly hay and partly for poultry. This gives wheat 24 acres, barley 84 acres, potatoes 80 acres (half early, half late varieties), sugar beet 30 acres, hay 12 acres, grass for hens 14 acres, mangolds 6 acres. The remaining acreage is in pig-runs and rough grazings. Owing to the light nature of the land and the small annual rainfall (about 24 in.) it is essential to maintain a large reserve of humus in the soil to hold moisture to tide crops over early summer droughts. This is done by the use of catch-crops and liberal dressings of farmyard manure. A catch-crop of Italian rye-grass and red clover is sown with all the grain-crops and rye-grass is sown after early potatoes.

The soil naturally produces good quality potatoes and this is encouraged by the liberal use of sulphate of potash. Owing to the shortness of the rotations, each variety is always planted on the same ground to avoid ground-keeper rogues. The early seed (Epicure) is sprouted in chitting trays and planted in early March. Except after the poultry, the land is dunged and artificial manure is applied at the rate of 4 cwt. sulphate of ammonia, 4 cwt. superphosphate, and 3 cwt. sulphate of potash per acre. The early potatoes are marketed as soon as possible in July and early August, the land being immediately sown with rye-grass, some of which is allowed to lie for a year to provide grass for the poultry and to be cut as hay. The late potatoes (Great Scot and Majestic) are grown from fresh seed brought each year from specially healthy stocks grown on our Perthshire hill farms. Besides dung, a dressing of 3 cwt. sulphate of ammonia, 3 cwt. superphosphate and 3 cwt. sulphate of potash is given. The crop is lifted and pitted and mostly goes as seed to England. The yield varies from 9 to 14 tons per acre.

Plumage Archer barley is sown at the rate of 2¼ bushels per acre in March. Owing to the danger of lodging, judgment in the use of artificial manure must be exercised. The dressing varies from no manure up to 1 cwt. sulphate of ammonia and 2 cwt. superphosphate per acre, according to the state of the land. The yield is about 8 qr., and the sample has always brought top price for malting. The soil is too light to be first class wheat land. This crop is sown after late potatoes and is treated with 1 cwt. nitrate of soda in the spring. The yield varies from 5 to 6 qr. per acre.

Except for a few acres of mangolds, the root crop is sugar beet. This is drilled on the flat in 22-inch rows in April. A dressing of lime is given during the winter and a dressing of 1 cwt.

sulphate of ammonia, 4 cwt. of superphosphate, and 3 cwt. potash salts 30 per cent at seeding is followed by a top dressing of 2 cwt. nitrate of soda after singling. The yield varies from 8 to 12 tons washed beet with a sugar percentage of 17–18.

Originally this farm followed the orthodox East Lothian practice of filling the courts with Irish store cattle in October, feeding them during the winter on swedes, oat straw and cake, and marketing them fat in the spring. By 1930 the increasing ravages of insect pests had reduced the swede crop to half the yield of ten years earlier, and oats were relatively unprofitable compared with barley. Pigs, in spite of the ups-and-downs previous to the marketing scheme, paid better than cattle, and cheap feeding stuffs with light transport costs were readily obtainable from Leith docks and flour mills. Existing farm buildings were modified and new piggeries erected, and eventually pigs and poultry replaced cattle as manure producers; and cash crops, sugar beet and barley replaced swedes and oats. By 1939 the farm stock consisted of 4 cows and 21 calves, 1,200 pigs, 4,000 poultry and variable flock of sheep.

The four cows are kept to supply the farm workers with milk and to rear calves. When six weeks old, milk-equivalent gradually replaces the whole milk in the calf's ration, and about twenty are reared in this way. They are marketed in early summer when 12–16 months old. The pig stock totals 1,200 Large Whites of various ages, including about 115 sows and gilts. The in-pig sows are kept in woodlands with huts as shelters, but are taken inside to farrow. When the young pigs are 4 weeks old the sow is put out to grass, and tethered beside a wooden hut, the young pigs running free and being introduced to meal in hoppers. When weaned at 8–10 weeks the young pigs are removed to the piggeries where, at 6½–7 months old, they reach bacon weight, and 25 to 30 are sold weekly to the factories.

A flock of about sixty half-bred ewes with a Suffolk ram is kept on sheltered grass for producing early lambs. The lambs are born in February (averaging 1¾ per ewe) and sold fat in June. A flying flock* of 300 lambs and fattening ewes is purchased in August and September, fattened on the aftermath, beet tops and catchcrop, and marketed from December onwards.

About 2,000 laying hens and 2,000 to 3,000 chickens, chiefly sex-linked Rhode Island Red × White Wyandotte and Light Sussex are kept in fold units and slatted floor houses on grass, and in semi-intensive houses with runs. The eggs are graded and packed in 1 dozen cartons under the National Mark* and retailed with roasting chickens and other farm produce in Edinburgh and district.

There are 5 horses, and one pony for feeding poultry. Besides the usual farm equipment there are two tractors, a motor truck, a retailing van and up-to-date machinery for grinding and mixing mash for the pigs and poultry.

The farm staff consists of 1 grieve, 1 woman-grieve, 3 horsemen, 1 tractor driver, 1 lorry driver, 1 vanman, 2 orramen, 2 pigmen, 1 poultryman, 2 poultry girls, and 5–20 seasonal casual female workers.

A DAIRY FARM IN THE SOUTH-WEST OF SCOTLAND

Situated 30 Miles from Glasgow.

DESCRIPTION BY

JOHN KIRKWOOD, B.Sc., N.D.A.

The extent is 145 acres, of which 19 acres are classed as rough grazings—for the most part steep braes.* A further 20 acres are not ploughable, consisting of peat with a profusion of surface boulders. Of the 106 remaining acres, 13 are in timothy meadow, and another 12 acres, because of steepness, are only ploughed at long intervals, when the pasture requires renewing. The balance of 81 acres, classed as a medium loam, is worked on a 10-years' rotation; 7, 8 or 9 acres being broken annually, depending on the size of the fields.

The lowest land, where the steading is situated, is 800 feet above sea level, rising to 950 feet at the highest point. The rainfall is in the region of 37–39 inches per annum, which is conducive to succulent pasture.

Crops.

The normal rotation of crops is oats, green crop, oats, hay, followed by 6 years in pasture. Generally speaking, this has been found to work well, although on some of the better fields, with nitrogen accumulating in the rotation pasture, there is a tendency for the oat crop to go down before harvest. As a preventative, hay is sometimes cut in the summer immediately before the land is broken up. The taking of a hay crop uses up some of the accumulated fertility and reduces the incidence of lodging. The actual cropping in 1939 was 14 acres oats, 7 acres green crop (consisting of ½ acre potatoes, 1 acre kale, 5½ acres turnips and swedes), 24 acres hay.

Manuring.

The scheme of manuring of the land in rotation is (per acre):—1, lea oats, 2 cwt. superphosphate, 1 cwt. potash salts; 2, green crop, 12–15 tons farmyard manure, 2 cwt. superphosphate, 3 cwt. steamed bone flour, 1 cwt. muriate of potash, with a nitrogenous manure in addition for potatoes and kale; 3, sow-out oats, 1 cwt. superphosphate, 1 cwt. steamed bone flour, 1 cwt. muriate of potash, and 10 cwt. basic slag; 4,

a 10-ton dressing of farmyard manure is put on the young seeds the first winter.

Lime is applied to all land once during the rotation. The time of application most in favour is on the top of the ploughed land, prior to seeding the sow-out crop of oats. But on some of the steeper fields, it is applied on the grassland before breaking up.

The timothy meadow receives dung every third year. In the intervening years 1½ cwt. " Nitro-chalk " is applied, and 8 cwt. basic slag every third year. Complementary to the manuring is a drastic annual harrowing in late winter or early spring. From the manurial treatment above outlined, it will be seen that the basis is ample phosphate, and periodic liming to prevent soil acidity. There has never been a crop failure of any kind. Yields are always well above the county average—oat grain, 24 to 30 cwt.; turnips and swedes, 24 to 36 tons; rotation and timothy hay, 2½ to 3 tons.

Varieties of oats which have been found to be most suitable are Marvellous, Onward, Star and Yielder. By adopting the practice of treating the seed oats with Ceresan, not only has the rate of seeding been cut down by fully a bushel per acre, but a much more even and healthy braird* has been obtained.

Boron at the rate of 20 lb. per acre is applied to all land to be under green crop. While raan or heart rot has never been much in evidence, the swedes grown on boron treated land seem to keep better than formerly, and little difficulty is experienced in providing sound, succulent swedes right up to the beginning of May. Three acres of Aberdeen green top yellow turnips are grown for use up to the end of February. These are shawed in November and stored in clamps. The swedes of which two to three acres are grown are ploughed or " sheughed " in. On this upland farm, this has been found to be the most effective method of preserving swedes for spring use. Two acres yielding a 25-ton crop is sufficient to provide 14 cwt. per day for 70 days, which allows of a ration of 40 lb. per head daily to the milk cows, and an average of 20 lb. per head for the younger cattle. This covers the period March, April and the first week of May, after which the young cattle are lying out and the cows are able to get out for a few hours' grazing.

Dairy Herd.

The dairy herd in 1939 comprised 28 pedigreed Ayrshires, 34 young female stock and a bull, all being home-bred except the stock bull. All heifer calves are reared. The best of the bull calves are sold for stock purposes when a week or two old. The herd is attested, and a licence is held for the sale of T.T. milk.

The maintenance of a fairly level milk supply all the year round is aimed at, and with this object in view an attempt is made to have 50 per cent of the calvings in the 4 months—September to December. Heifers are timed to calve when 2½ years old. The allowance of milk fed to calves is 80–90 gallons, an average of one gallon per day for 12 weeks. Good quality hay *ad lib.* and a concentrate mixture consisting of oats, linseed cake, maize, locust beans and a little fish meal are fed from 3 weeks of age. Calves born after the end of June are not turned out to pasture until the following year, while those born in spring or early summer are turned out to grass when 8 weeks old. With the onset of hard weather young cattle are housed (tied in stalls) in airy, well-lit buildings, generally from the beginning of December to the beginning of May. During this period, however, they are turned into the fields from 10 a.m. to 3 p.m. daily. The bite of grass thus obtained is considered to be very beneficial. Hay and the root allowance are given in the morning, and 2½ lb. concentrates (chiefly oats) when they are brought in during the afternoon. For the last feed at night those over one year old get a foddering of straw and the younger ones hay. Heifers within 3 months of calving receive 4 lb. concentrates which invariably contain a little white fish meal.

The dairy cows are housed at night from the middle of October until about the 20th May. Milking, which is done by hand, commences at 5-30 a.m. and 4-15 p.m. All are given hay, straw, roots and 3 lb. concentrates calculated to provide for maintenance and the first gallon of milk. For all milk in excess of one gallon concentrates are fed according to yield. After the visit of the milk recorder (every 4 weeks) a sheet is made up showing the quantity of concentrates which each cow is to receive twice daily, and is expressed in terms of the measure used.

The change over from winter feeding to grass is a gradual process, and for the first two or three weeks when the young grass is succulent and protein rich and the cattle are lying out at night it is customary to feed at milking times a little starchy concentrate mixture such as oats, flaked maize and locust beans. Thereafter only cows yielding 4 gallons and over receive a concentrate allowance, a full production ration being given for all milk above that figure. In the end of August and in September clover or timothy aftermath supplements the failing pasture until the marrow stem kale is forward enough for cutting. The actual production for the calendar year 1939, averaged 813 gallons per cow.

Sheep.

While sheep are subsidiary to the dairy herd it is recognized that they play a small though important part in the general farm economy. A flock of from 50 to 60 ewes is kept, generally Half-breds and Leicester Blackface crosses. They are mated to a Suffolk ram, lambing time starting about the middle of March. In 1939, from 56 ewes mated in October, 96 lambs (171 per cent crop) were sold. In addition, 17 ewes with 29

lambs at foot were bought in the end of April and both ewes and lambs cashed before the end of September. The lambs are sold fat as milk lambs in June, July and August. The smaller lambs, usually about 20 per cent of the total, are fattened off on foggage.* The feet of all ewes are pared four times annually; in September when selecting the ewes to be retained, at Christmas before they are too heavy in lamb. Again within 24 hours of lambing, when the udder of each ewe is examined and any wool removed, advantage is taken of the opportunity to attend to the feet. The final paring is given at clipping time. As a consequence of this *regular attention* very little lameness is experienced during the intervening periods.

On a number of the best fields ragweed was wont to appear particularly in the early years of rotation pasture. To counter this it was decided some years ago to have sheep on all grassland from the beginning of May until early autumn; even on fields allocated to the milk cows, every two acres to carry at least one ewe and her lambs. Ragweed and some other weeds have entirely disappeared, no depression in the milk yield has resulted and the sheep thus dispersed do exceedingly well.

Labour Employed.

The regular staff consists of a married ploughman, a married cattleman, a lad about sixteen years, a dairymaid, an extra milker and the cattleman's wife as a reserve milker. At busy seasons such as at turnip thinning and haymaking all have to help with the field work, and in addition a small amount of casual labour is employed.

A strict tally is kept of all roots carted in and all grain threshed so that the winter feeding programme can be planned according to the supplies available.

The revenue from the different departments of the farm, when expressed in terms of percentage was for 1939 as follows:—Milk 68 per cent, Cattle 14½ per cent, Sheep 12½ per cent, Crops 4 per cent, Poultry 2 per cent.

The keynote of the system has always been to have good quality pasture for summer grazing and a sufficiency of hay and roots for winter keep; and in particular to provide succulent food in the form of swedes right up to the time the grass comes. This last is conducive to health in the cows, and is a big factor in preventing digestive trouble such as stomach staggers.

A WELSH FARM

DESCRIBED BY

PROFESSOR E. J. ROBERTS, M.A., M.Sc.

THE agriculture of Wales is determined by its topography and rainfall. It is a mountainous country, and, in consequence, carries large numbers of hill sheep, mostly of the Welsh Mountain breed; in 1939, the total number of sheep was approximately 4½ million. There are, however, in addition to the hills, fertile river valleys, and also comparatively extensive areas of fairly flat land, where the farming would be much the same as in similar areas in the west of England; in the county of Anglesey for example, most of the land is approximately at sea level. The rainfall in the mountainous areas is heavy, while in the valleys and areas of low ground it is moderate. There are only very few isolated spots where the average rainfall is as low as 26 inches per annum. The lowland of Wales is, in consequence, good grass country, and, in 1939, out of nearly 2¾ million acres under crop and grass, there were only approximately 200,000 acres under arable crops, that is, rather more than a tenth of that area.

The higher portions of the hills are grazed by the sheep in summer only; it can be readily understood that land over 2,000 feet above sea level not only carries too little food to support the flocks in winter, but also may be covered with snow for several weeks. The hill flocks are thus brought to the lower portions of the hills, or on to the low ground, for the winter. Many hill farmers arrange to have the ewe lambs wintered away on comparatively good grassland; this relieves the pressure of winter grazing at home, and gives the lambs an opportunity of growing on the better land elsewhere.

The hill ewe spends the latter portion of her life as a profit-maker for the lowland farmers of Wales, becoming the grass ewe that produces the well-known grass lamb; after rearing about 3 crops of lambs on the hills, the ewes are sold for crossing with rams of the down breeds, and, thanks to carbon tetrachloride, may be retained for a further two or three years before being sold fat. The Welsh Mountain ewe is highly suitable for this purpose owing to her capacity to milk heavily even on a low plane of nutrition. The grass flocks have played an important part in the economy of most Welsh farms, having given good returns for little capital, and necessitating very little labour. The tendency to put more and more land down to grass, and to farm with a "dog and a stick," was deplored by many who had at heart the welfare of Welsh agriculture.

The production of store cattle has always been an important feature of Welsh farming, and was linked up with butter-making. The policy of the Milk Marketing Board, however, resulted in an increase in the production of liquid milk for sale, and, consequently a decrease in separated milk and butter-milk for calf-rearing. This movement towards milk selling has been accelerated since 1939, not only by Government propaganda in favour of producing milk for sale irrespective of locality, but also by keeping down the price of butter at a level which

makes butter-making definitely unremunerative.

The effects of war on Welsh farming were to increase considerably the area under the plough, and to do this mostly at the expense of the grass sheep. Official statistics were not available to the public in the war year, but it is probable that, while the numbers of hill sheep remained much the same as in 1939, the grass sheep were reduced to about a half of pre-war figures. The hill sheep subsidy is granted in order to maintain the number of hill sheep.

There are thus many types of Welsh farms, ranging from those situated entirely on fertile land at sea level, such as those near the Cheshire Plain in East Denbighshire, to the true hill farm. The following is a description of a well-farmed holding of the latter type lying between 400 and 800 feet above sea level.

The farm is 4 miles from a small market town. It is 150 acres in extent, and the soil, a medium loam with no lime deficiency, is all cultivable. In 1939 it was worked by the farmer, his son and one lad, with extra labour for hoeing and harvest.

In 1939 the stock consisted of: a flying flock* of 130 Welsh ewes; 50 cattle of all ages, including 12 milk cows; in addition to the home-bred calves about a dozen were purchased each year for rearing; 5 horses, which included one team of working horses; a small complement of pigs and poultry. There were then thirty acres of land under the plough, of which six acres were under roots, eight acres barley, and sixteen acres oats.

The main source of income was obtained from fat lambs, of which about 130 were sold each year during July, August and September. The lambs from this farm realized a comparatively high average price—35/- per head. The success obtained with the lambs is attributed to (1) providing extra food, in the form of an acre of mangolds for the ewes at the time of lambing; (2) running the sheep on young leys. Other farmers who did not provide these, not only received a smaller price per lamb, but had, at the end of the season, a number of culls* that had to be kept on until the following spring.

The income from the cattle consisted of the proceeds from the sale of (1) 3 or 4 cows in full profit each year; (2) about a dozen 2–2½ year-old fat bullocks or heifers; (3) a small quantity of butter.

All the work on the land was done by horses. These included two Shire mares, kept for breeding, which enabled a 4- or 5-year-old horse to be sold nearly every year. This greatly reduced the cost of the stable, and enabled horse labour to be provided at a comparatively low cost.

The implements consisted of: plough, roller, cultivator, tooth harrow, chain harrow, ridging plough, horse-hoe, corn drill, root drill, hay mower, self-binder, hay rake and two carts.

All this had been changed by the summer of 1942; by then the area under the plough had been increased by 45 acres, so that there were 75 acres of arable land. The crops grown were: 5 acres roots, 6 acres potatoes, 15 acres barley, 39 acres oats and 10 acres wheat. The increase in the arable acreage made it necessary to purchase a tractor and a two-furrow tractor-plough. The remainder of the tractor-drawn implements required were hired from the War Agricultural Executive Committee. Additional labour, a tractor-driver capable of doing general farm work, became necessary.

In the war years the dairy herd, which is a reliable source of income, and also helps to maintain the fertility of the soil, was kept up to pre-war strength; but only sufficient butter was made to supply the household, the remainder of the milk being sold. All the home-bred calves were reared, but only about half the pre-war number was purchased, and there was a corresponding reduction in the output of fat cattle. It was also necessary to reduce the flock to 70 ewes. The reduction in revenue from sheep was more than balanced by that from the dairy herd and from cash crops.

A NORTH OF IRELAND FARM

DESCRIBED BY

ROBERT HALE, B.Sc.

(*The Agricultural Research Institute of Northern Ireland.*)

THE agriculture of Northern Ireland is typically of the small-holding type. Over four-fifths of the farms are less than 50 acres in extent and are worked almost entirely by the farmer and his family. Through the operation of the Land Purchase Acts, the majority of the farmers are either owners, or on the way to becoming owners of their holdings. Such a type of farming, together with the equable and humid climate, provides very suitable conditions for stock-farming based on a mixed-cropping system. The typical smaller farms are practically self-contained. The farm household subsists very largely on oats, potatoes, milk, butter and eggs produced at home. The livestock, which can graze from May to October or longer, are mostly fed on oats, hay, swedes and kale from the farm. Pigs and poultry were the only stock which before the war consumed any quantity of purchased feeding stuffs on the smaller farms. Near the larger towns there are of course larger farms of more specialized commercial types, usually engaged in liquid milk production.

The amount of tillage is much greater in the east than in the west of the province, but over the whole the area under crops and hay was nearly 40 per cent of the cultivated area even before the war. Alternate husbandry is the almost universal system of cropping, a sound policy which has maintained the health of the stock in

spite of the relatively large numbers kept on small areas. The typical rotation of oats, potatoes and swedes, oats, hay for one or two years, and grazing for two or three years, is well adapted to the climate and to the usually sour soils. The main cash crops were potatoes, flax and rye-grass seed before the war, but oats, wheat and barley have increased in importance since the ploughed area has been extended under the Tillage Orders.

The importance of stock farming is shown by the fact that about 80 per cent of the value of the agricultural production of Northern Ireland was derived from livestock products before the war. Much the greater part of the cattle are of the dual-purpose Shorthorn type. Before the war, nearly three-quarters of the milk was used for butter-making mostly by co-operative creameries, but this industry was re-organized in 1942 to provide liquid milk for export. The great store-cattle trade has been rapidly giving place to fat cattle during the past 10 years or so. Sheep are found on most farms, but are not of importance except on the mountains. Blackface ewes are crossed with Border Leicesters to produce the Crossbreds which are the favourite breeding ewes of the lowland farmers.

By 1939 pig production had reached great importance, practically all the stock being Large Whites. The Wiltshire bacon trade took most of the pigs under the pre-war pigs marketing schemes, but the local Roll and Ham cure, for which the soft-skinned Large White Ulster breed was specially suitable, is still important. There is practically no market for porkers in Northern Ireland. Many small farmers concentrated on rearing stores for sale to specialist feeders. But the number of pigs has been reduced to probably a quarter or a third of its 1939 level. Poultry-keeping is largely the responsibility of the women-folk, but has been built up to be one of the most important branches of farming, and the number of hens in the country has been maintained to a remarkable degree.

A representative farm from the Belfast area employs the farmer, his son, and not more than two men. This holding is on the borders of the hillocky "drumlin" country which forms so much of County Down, the soil being a medium loam varying somewhat according to the nature of the underlying glacial deposits. It extends to 58 acres, but a further 22 acres have been farmed for a number of years on the "con acre" system, a local custom by which the land is let, strictly speaking, for only eleven months of the year, the Land Purchase Acts making it inadmissible to sub-let land permanently when it is being bought out.

The 80 acres are divided into fifteen fields (which are thus rather larger than those on many farms in Northern Ireland) most of these fields have always been under "alternate husbandry" on a fairly common local rotation in which the first crop after grass is oats. This is sown down with pure Italian rye-grass which is harvested for seed in the second year. The root break in the third year contains potatoes, cabbages and swede turnips. This is followed by oats or barley sown down with a good seeds mixture in which the principal grasses are perennial rye-grass, cocksfoot and meadow fescue. The grass is cut for hay in the first year and then grazed for two or three years as required. To meet the wartime Tillage Orders an increased area has been brought under cereals so that rather more than the required 45 per cent of the "arable" area is under crops (excluding hay). To make up for some of the loss of grazing, the cereals are under-sown with Italian rye-grass to provide a winter catch crop* even when a second cereal crop is to be taken.

The farmer was one of the first in Northern Ireland to rely entirely on a tractor. Already in 1938 two of the usual three horses were replaced by a Ferguson tractor, which in the succeeding years did practically all the field work (except haymaking) on this farm and on a neighbour's farm. The set of directly-attached implements for this tractor include a 2-furrow general-purpose plough, a 3-row ridging plough, a row-crop cultivator, and an ordinary cultivator with spring-mounted tines. Horse-drawn harrows, roller, binder, mower and hay bogeys (rick-shifters) were adapted for use with the tractor, and a tractor cart was bought. Hay rake, tedder and collector continued to be drawn by horse.

About 30 head of cattle, mostly bullocks for fattening, are generally on the farm, only 4 cows being kept for supplying the house. Until 1939 the bullocks were mainly fattened off in the winter, but later when there was no ration of purchased meals for fat cattle in Northern Ireland they were carried through the winter on grass silage, turnips and hay and were finished on grass, in June if possible.

The speciality on the farm is the ram-breeding flock of Border Leicesters, which now contains about 20 ewes as compared with about 30 in 1939. The owner has for many years been a most successful exhibitor of Border Leicesters in Northern Ireland, and has also taken many prizes in Dublin. In 1942 he carried off all the championships at the Ulster Ram Breeders' Sale and obtained the top price of 40 guineas for a ram lamb.

Pigs and poultry were formerly important sources of income but war time conditions led to a drastic cutting down of stock. Previously 30 Large White sows (mostly pedigree) were kept and their progeny fattened, there being accommodation for about 300 pigs on the farm. During the 1939–45 war stock was reduced to only 5 sows, but pedigree breeding was still carried on. Pre-war, 500 head of Rhode Island Red laying hens were kept, and all replacements were bred on the farm.

A WILTSHIRE ARABLE SHEEP FARM

BY

W. T. PRICE, M.C., B.Sc., P.A.S.I., N.D.A., N.D.D.

THIS Wiltshire arable sheep-farm lies on the Chalk Downs, and it is a mile and a half from the village, and the farm buildings are a similar distance from a main road. These buildings, together with four cottages to house the shepherd, the horseman and the other two farm-workers with their families, are just sufficient for the farm's requirements; any additional workers come from the village each day.

The farm is 550 acres in extent, some two miles long and varies in width from 500 to 900 yards, while the land is part of two undulations in the rolling downland with a steep fold between the two crests.

The 400 acres of arable land lie on the more gentle slopes. There are some 30 acres of sheep-pasture where it is too steep to plough. Just over 100 acres of downland sheep-pasture run up to the top of the second crest, of these 40 acres are known as the Bake. There are 10 acres of horse-pasture adjoining the farm buildings.

The farm is unfenced with the exception of the horse paddock. The water supply consists of a well at the farm buildings and two dew ponds which are catchwater-excavations lined with puddled clay.

The soil is chiefly on white chalk, being light and free draining on the lower ridge, while on the second slope it has some admixture of Clay-with-flints and changes gradually to a cap on part of the downland sheep pasture to finish up with light calcareous soil.

The rotation is a very old and set system of cropping, developed in the nineteenth century when corn prices were profitable and when, with the exception of phosphates for the swede and turnip crop, artificial fertilizers were seldom applied. Half the arable area is cropped with sheep foods, the other half being cereals. The rotation is an eight-year cycle, as follows:

1st Year.—Swedes and thousand-headed kale for folding with ewes and lambs from Christmas until spring.

2nd Year.—Early sown turnips and rape for folding-off during autumn in preparation for a wheat crop.

3rd Year.—Wheat.

4th Year.—Spring-barley under sown with a one-and-a-half year ley consisting of broad red clover and Italian rye-grass.

5th Year.—Seeds-ley cut for hay, the aftermath is grazed (not folded) by sheep for a few hours each day to add variety to the diet of the flock folding on turnips. The seeds-ley is kept free from stock during late autumn and winter to provide early grass for the ewes and lambs during the following spring.

6th Year.—Folded with sheep. After folding the seeds-ley is ploughed and bastard-fallowed in preparation for autumn-sown wheat.

7th Year.—Winter wheat.

8th Year.—Either winter-barley, winter-oats, or spring-barley, to be followed by areas of the following extra crops preparatory to the rotation starting again:—

Italian rye-grass and trefoil may be sown in the spring-barley crop during the previous April.

Areas of rye, winter-barley, winter-oats and vetches sown during the autumn. These crops provide sheep food for ewes and lambs the following season. [Rye during late April and early May; winter-barley later and vetches during June and July until the turnips are ready.].

The sheep are very important on the farm as the flock governs the cropping of half the arable land. The breeding policy is to have a self-supporting of young Hampshire Down ewes replenished with home-bred females, and it is only the rams that are purchased. The flocks consists of 350 ewes in regular ages, approximately one-third 2-teeth, one-third 4-teeth, one-third 6-teeth. Each year the oldest are sold (as draft-ewes, for further breeding on the lowland farms) and the flock is made up to 350 before the mating season, again with 2-teeth ewes.

The wether lambs are sold to the butcher as they become fat enough during the spring and summer, while the chilver (female) lambs are kept to replenish the flock for the following season. In seasons when crops are poor, the store wether lambs and cull chilver lambs are sold at the sheep fairs (at the same time as the draft ewes), but the usual practice is to fatten these lambs on turnips during the autumn. When there is a particularly good turnip crop extra lambs are purchased for fattening in order to clear the crop for wheat sowing.

Two lots of about 20 cattle are kept in the old ox or horse yards during the winter to tread straw into dung; these animals must be disposed of before spring as there is no place for cattle in summer in a district in which the Down (sheep pasture) starts growth so late in spring, quite apart from the lack of an adequate water supply and fences.

Each day the sheep have a fresh fold of succulent food. The size of the fold is determined by the type and quality of the available crop and will vary between one-quarter and half an acre. The lambs or fattening sheep have access to the folds first, while the ewes clear up the residue the following day. According to season the arrangements of the actual folds is made to cater for the sub-division of the sheep into suitable lots, and this, as well as the pitching of the folds, is part of the shepherd's work. The wattle-hurdle which is used for the fold, in addition to acting as a fence, provides a valuable windbreak. The shepherd, who may be assisted by an under-shepherd, each day takes up the oldest folds and

pitches new ones so as to fold off the crop and manure the land systematically, and his work also includes tending the ewes for some hours each day on the open down pasture for many months of the year.

During late January and February lambing-time necessitates special provision of shelter from the elements for both sheep and shepherd. Miniature stock-yards are made of hurdles and straw, while the lambing-pen and its sub-divisions cater for the special needs of the flock during the lambing period, after which the straw used as litter is made into dung for the land. In winter the ordinary folds are littered with straw to be trampled in.

Great store is placed upon the value of the sheep to manure the farm, but in recent years it has been the practice not to rely solely on manurial residues, but to supplement the fertility from the sheep by the freer use of complete fertilizers for the barley, and nitrogenous top-dressings for the wheat on the least promising fields.

The war period brought modifications, inasmuch as the 40 acres of Bake and 20 acres of virgin downland-pasture was put under the plough, and carried a crop of oats and barley, and another 25 acres was ploughed and sown to barley, while 40 acres of the root area used to grow barley as a third straw crop, was grown with the aid of artificial fertilizers combine-drilled with the seed. This reduction in sheep-pasture and in sheep-folding crops necessitated the ewe flock being cut down from 350 to 300.

The balance of labour and work throughout the season which was originally designed for horses and a permanent staff of men, was, of course, upset by an increase in the acreage of cereals, because two tractors did most of the cultivations and the horses were required chiefly for odd jobs. On the other hand, seasonal labour became necessary at harvest time to supplement the permanent staff of five men and a boy, and a combine-harvester thresher was now required to handle the barley crop.

In order to cope with the rush periods at seeding time, harvest, and the cleaning of stubbles, which must be carried out with all possible speed during the good weather, the tractors were kept going from daylight to dark during favourable weather in spring and autumn.

During the war it was decided that unless the head of sheep was built up again, as the land went through rotation the ploughing-in as green manure of such crops as mustard and broadcast rape, would be practised.

The use of a track-laying tractor would reduce the area of land previously considered too steep for the cultivation to a very small acreage. This steep land was surveyed during the war to ascertain its possibilities as temporary arable land, with the idea in mind that it would eventually be sown down again with modern strains of grasses and clovers to establish a more productive sward. In the meantime 25 acres of common sainfoin were sown in the lightest chalk field.

Electric fencing is under consideration, as well as the establishment of an improved water supply by the construction of a reservoir from which water could be led by gravity to drinking troughs in most of the fields.

This typical sheep farm is enjoying the conditions for which it was originally designed, namely, the production of corn and the maintenance of fertility.

A MIXED FARM IN KENT

under War time conditions

BY

THE AUTHOR

MANY farms to be found in Kent, Surrey and Sussex are characterized by the number and diversity of their products. Some of them are highly specialized and are farmed intensively. A very good example of this type is described below as it existed round about 1943.

This farm was 225 acres in extent in 1939. During the war 40 acres of derelict land were added to the holding. The land has a gentle slope to a river which, lying at the lower end of the farm, periodically floods the adjoining meadows; there the soil is alluvial, whilst that of the higher fields is a silty loam. The soils are deep, and their mechanical condition is good; they are not naturally rich in plant food, and owe their present fertile condition to the cumulative effect of many years intensive farming.

A good water supply is necessary for this type of farming. This holding is supplied from a Company's main which passes along the adjoining road. Another asset is that along the same road is an electric supply from which the current is obtained to drive the fixed machinery, and to light the farm buildings. It is difficult to over-estimate the value of these two services.

It being held that diseases and pests if unchecked are liable to make serious inroads into farm profits, their control is a notable feature in the organization of the farm.

The crops grown in the years 1939 and 1942 were:—

	1939 Acres	1942 Acres
Permanent pasture ..	66	44
Temporary pasture (4–5 year leys)	12	7
Lucerne	—	7
Wheat	16	30
Barley	—	20
Oats	10	18
Beans or peas	72	6
Potatoes	20	31
Mangels	2	3

	1939 Acres	1942 Acres
Cabbage, brussel sprouts and other vegetables ..	7	13
Canning peas	—	10
Swede seed	—	10
Runner bean seed ..	—	1
Rye grass seed	7	—
NURSERY STOCKS		
Strawberry runners ..	6	3
Raspberry canes	1	1
Hop sets	2½	—
SOFT FRUIT		
Red currants	6	
GRASS ORCHARDS		
Standard cherries and plums	39	39
HOPS..	23	23

The raspberry canes and strawberry runners are specially selected for freedom from mosaic diseases. The peas, swede-seed and runner bean-seed are grown under contract. Sheep and poultry are run in the grass orchards.

The farm buildings, though not elaborate, are adequate and include a cow-shed which has been remodelled to make it conform to modern requirements; they are kept well stocked during the winter months. A considerable amount of F.Y.M. is produced, part of which is applied to the hop garden, and the remainder to the potato land. Both of these also receive a dressing of artificials. Practically all the other crops are manured with artificials. Pastures are periodically limed and dressed with phosphates. The manuring is combined with efficient cultivation and the result is first-class crops. An idea of the standard of fertility which has been built up can be formed from the fact that an average wheat crop yields 30 cwt. of grain per acre, whilst as much as 54 cwt. has been grown.

It is necessary to cultivate cereals which will stand up to heavy yields, and Holdfast wheat and Supreme oats are usually grown. Barley is only cultivated on the derelict land—Sprat-archer being the variety grown.

Hay is produced on the leys, the first cut being reserved for that purpose. The latermath is grazed. The seven acres of lucerne cultivated in 1942 were grown to make good the shortage of pasture caused by ploughing grassland. The lucerne is used green, any surplus being made into silage.

It is notable that of the 1939 arable land which was 79 acres in extent, 77 acres carried crops which could be sold; but owing to the mixed character of the holding all the corn and the cabbage could be consumed on the farm if the market prices were too low to make their sale desirable.

Turning now to the stock, the figures were as follows:—

	1939	1942
Horses	8	5
Cows and heifers	22	28
Ewes	200	100
Pigs	8 Sows	Nil.
(The progeny was fattened to make 7–8½ score baconers.)		
Fowls	300	150

In 1939 nearly all the horses were old. These had been replaced by younger animals in 1942; in addition a second tractor had been purchased. In this way sufficient power was provided to deal with the extra arable acreage, and to help several small farmers who had not the equipment required under war conditions.

The number of cows had been increased by 1942 in response to the demand for milk, whilst the sheep had been reduced partly because of the increase in the dairy herd, and partly owing to the reduction in the area of pasture. Pigs were not kept in 1942 because of the shortage of feeding stuffs, which also accounted for the reduction in the poultry.

The dairy herd is an interesting feature. At its inception, Ayrshire heifers were chosen, because in this breed it is comparatively easy to find good milkers and to purchase tuberculin-tested stock, and they were crossed with a Guernsey bull; subsequently Ayrshire and Guernsey bulls were purchased alternately. All the heifer calves are reared, those not required being sold as in-calf heifers. The herd is tuberculin-tested and has reached the stage at which it is exceptional for an animal to react. The owner considers that by obviating losses from tuberculosis, the testing fully justifies itself. Calves are dishorned by the application of caustic potash when they are three days old. This practice prevents the cattle from damaging one another, and a yard will hold many more cattle when dishorned. Milking is done by machine. A refrigerating plant is used to cool the water used in the cooler, and the milk, which is retailed locally, is bottled. The bottles are filled by a simple machine and power-driven brushed are used for cleaning the empty bottles.

The flock is maintained by purchasing three lamb* Kent ewes which are crossed with a Southdown ram. Whenever possible two crops of lambs are taken from them, after which they are fattened. In 1939 half the lambs were sold fat off the ewes; the remainder were fattened on the leys and sold in the early autumn.

Lastly, there is the hop-garden.—Hops are a semi-permanent crop; the poles of hop-gardens are a characteristic feature of the landscape in some parts of the south-eastern counties, and of Hampshire, Hereford and Worcester; the crop is not grown in other counties. It needs a comparatively large amount of cultivation and is very expensive. Here Golding varieties are grown. During the winter the land in between the rows is cultivated and manure is applied to the hills. Each spring every plant is examined

and rogues are removed, and stringing is then carried out. Here it is usual to spray about eight times during growth to protect the crop from disease, and to dust twice with sulphur. The spray is pumped through the garden from a central pumping station, and applied by a horse-drawn power driven spraying machine. Picking is done early in September, mainly by women. It is comparatively remunerative work which is usually done under congenial weather conditions, and upon this farm it is done by the same women year after year. The crop must be dried and the farm is equipped with a modern oast (i.e. a drying-tower), the crop being dried by forced draught, which is controlled by fans driven by electric motors.

The labour employed was:—

	1939	1942
Men	18	17
Boys	2	3
Women (average)	5–20	10–30

A larger staff was necessary in 1942 than in 1939 for three reasons. In the first place the area of arable land had been increased by about 67 acres. Secondly, the reduction in working hours meant that a larger staff was required to do the same amount of work. Thirdly, this farmer was actually keeping a few extra hands, especially during the winter, so that he had at his disposal sufficient staff to enable him to send help to some of the small farmers at busy times when they could not manage to farm efficiently with their own small staff.

A HAMPSHIRE SHEEP FARM BEFORE 1939—YESTERDAY AND UNDER WAR CONDITIONS

DESCRIPTIONS BY

H. RANSOME

It has been widely held for over 200 years that sheep folded on arable land maintain and increase its fertility, and that the treading action of the sheep improves the texture of the lighter soils.

In the drier parts of England, mainly the east and south, and on the lighter soils either sands or chalks, this practice has been valuable in keeping up the chemical and organic fertility level, due largely to the fact that hay, cake and corn were fed to the sheep in addition to the roots they ate on the ground.

The demands of the system are well illustrated by the following example of a typical Hampshire farm on chalk land. In 1939, the last pre-war year, the cropping was:—

Grass	324 acres
Corn Crops	244 acres
Roots and Forage	110 acres
Seeds and Sainfoin	132 acres
Total	810 acres

It will be seen that approximately half the arable land was under corn, a quarter roots, and a quarter seeds or sainfoin. The rotation may be described as a double cycle of the Norfolk Four-Course, except that in two successive years out of eight the land carries crops to be eaten off by sheep. The sequence of cropping is:—1, Roots; 2, Wheat; 3, Barley; 4, Seeds; 5, Oats; 6 Roots; 7, Barley; 8, Seeds. The land carrying the last seeds crop was usually ploughed up in June after the hay had been taken, and put into late roots, either rape or turnips, thus getting in an extra folding crop before the main crop of roots which preceded the wheat. As good malting barley was usually grown after a wheat crop, this double fold got the land into good enough heart to stand two straw crops in succession. An essential part of the system was that the ewes and lambs were provided with a generous allowance of cake and corn, and for several months in the year the hay racks were filled with sainfoin or clover hay. This accounted for the building up of the fertility of the soil. More plant food was returned to the soil than was taken away as wool or mutton.

It will be realised that on such a farm the shepherd's demands were almost dictatorial, as it was essential to have a regular succession of green forage or root crops available for the flock. With 250 ewes and their lambs (the latter being fattened on roots during the autumn and winter) a second shepherd was required for several months in the year. His spare time job was making hurdles from the hazel rows which acted as hedges and pheasant covers. Incidentally, a part of the root crop acted as an attractive hide for game, and the shooting value of these farms is comparatively high.

War-time conditions restricted the practice of sheep folding to a considerable extent because of:—

(*a*) The shortage of labour; before the war 20 men were employed; the strength in January 1943 was 12 men and 4 land girls.

(*b*) The demand for more corn, and the wish of the farmers to grow it.

(*c*) The demand for more milk and for young cattle to grow into cows.

So we find this farm arranging to grow in 1943:—

Grass	165 acres
Corn crops	410 acres
Roots and forage	25 acres
Potatoes	10 acres
One-year ley	110 acres
Three-year ley	90 acres
Total	810 acres

This farmer went a long way to adapting his farm to war-time conditions. He ploughed up 160 acres of grass, reduced his roots to the 25 acres required by the increased dairy herd and their followers, arranged to grow his quota of 10 acres of potatoes, increased his corn acreage from 244 to 410 acres, and got one new item—90 acres of 3-year ley. Two-thirds of the arable land grew corn, instead of one-half before the war. That is why the new item appears—the 3-year ley. Some of this was put down in 1941 and some in 1942. A grass and clover mixture containing some of the Aberystwyth strains of perennial rye-grass and cocks-foots with a suitable proportion of clovers, was used. The new leys were grazed during their first season, but the cattle were kept off during the first winter of their life to avoid poaching.

The essential requirements for managing leys are fencing and water. On the farm in question short extensions of the present water scheme were made to some fields while others that were pasture pre-war had water already laid on. One field had a corrugated iron roofed shed extended so that it served to catch sufficient water to last a bunch of cattle unless an exceptionally long drought is experienced. The main merits of leys under the new conditions were found to be:—

(*a*) Economy of labour compared with that required for sheep folding;

(*b*) The leys will carry much more stock per acre than the old "Hampshire pastures." (Before the war 40 cows were milked and about 45 young stock were carried. During the war 65 cows were machine-milked and their followers numbered 87.) The young stock throve better and the milk-yield from cows grazing on them was good. (One difficulty was to persuade the cowman to keep his cows off the new leys when they were so wet that the cattle hoofs made holes and damaged the young grass.)

(*c*) The dung from the cattle grazing, together with the restorative action of the clovers, improves the land both as regards its humus content and plant food. After 3 years as a ley there is something there for a corn crop to feed on, especially when home-grown corn and purchased feeding stuffs were fed to the cows.

Thus we find the sheep folding system used extensively since the turnip was popularized by Townsend about 1700, giving way to ley farming, preached and practised by Stapledon since 1920. The principles are the same; vegetable growth eaten off, where it grows, by animals, their dung returning to the land, and the fertility thus built up used to grow grain for feeding man and beast.

A MIDLAND DAIRY FARM

DESCRIBED BY

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THROUGHOUT the Midlands there is a large number of dairy farms. The majority of these sell liquid milk, but before the war there were, in certain areas, such as Cheshire and Leicestershire, a few farmhouse cheese-makers.

In recent years the tendency has been for cheese-making to be concentrated in factories situated in villages or market towns and drawing their milk supplies from farms which formerly made cheese.

The management of a farm-producing milk for cheese-making was based upon summer milk production; mainly young home-bred cows were kept, and these calved down in March and April so that they produced the main proportion of their milk during the cheese-making season, which lasted from April to September. Any milk produced during the winter months was sold liquid. Purchased concentrates were used fairly heavily, whilst winter feeding was relatively light compared with that of a herd producing milk for the liquid market. Whey was a bulky by-product of farmhouse cheese-making, and the general practice was to use it for pig-feeding; young pigs could not consume large quantities and strong stores were purchased at about 20 weeks old, preferably Large Black and Large White, and finished to bacon weights.

As a result of war-time restrictions, farmhouse cheese-making ceased, and with it, pig-feeding on these farms. The milk was sold on a whole-sale contract. The farmers also turned to arable farming. In this they were handicapped by labour difficulties arising from the change-over from a seasonal to an all-the-year-round demand for labour.

Throughout the East Midlands are numerous dairy farms mostly from 50 to 100 acres, carrying a milking herd and raising young dairy stock. There is practically no other source of income direct from the land. The labour is mostly of the family type. Before 1939 milk was the main source of income of these farms, which were either all grass or with just a few acres of plough-land. The methods of farming were based upon the fact that all the concentrates required could be purchased. Pig and poultry enterprises were started to increase profits while absorbing practically none of the farm acreage for their maintenance.

Investing his annuity after the last war in a small dairy farm, Mr. X moved to his present holding in S.W. Leicestershire about 1928. By then he had the nucleus of a non-pedigree short-horn herd which consistently milked heavily in recent years. His experience is common to many,

whether farmers' sons, farm workers or newcomers to farming; weathering the depression of the early 1930's, these dairy farmers ran into fair weather as the milk-market became stablised under the guidance of the Milk Marketing Board.

Prior to the outbreak of the war, this farm consisted of 89 acres rented at nearly £2 per acre, 39 acres grazed and 50 acres mown for hay. In addition, 35 acres of grass-keeping was taken, mainly as summer grazing for the sheep and some young dairy cattle. The grassland had been well managed, receiving regular dressings of lime and basic slag. The soil was mostly of medium quality but some lighter and poorer patches occurred. The same fields were mown for hay each year and these received heavy dressings of farmyard manure which had to be spread somewhere, there being no arable land to absorb it. Hay harvest was treated as the most important event in the farming year and a good crop of June-made hay was usually obtained. One year a wet June and July meant a low-quality hay crop and milk yields suffered the following winter.

This farm was carrying in the autumn of 1938:—2 work horses, 19 dairy cows, 41 other cattle including 3 feeding bullocks, 60 breeding ewes, 4 breeding sows, 40 fattening pigs, 50 poultry (mixed).

The Work Horses.

Two good Shires were kept and, if possible, a foal was bred each year.

The Dairy Herd.

The only purchases for many years have been pedigree Dairy Shorthorn bulls selected for milk pedigree rather than show pedigree. From a few foundation cows an excellent herd of non-pedigree Dairy Shorthorns of good type and conformation was built up and the home-bred heifers proved consistently heavy milkers as well as being very pleasing to the eye. During the year ending 30th September, 1939, when the herd included six cows calving down with their second calf and eight heifers calving for the first time, the average yield per cow was 760 gallons. In previous years, with a higher proportion of older cows, average yields up to 940 gallons had been obtained. Feeding was on a high plane and with grass and hay in short supply, the hay allowance being about 11 lb. per head per day, purchased concentrates (usually flaked maize, bran and beet pulp and a high quality proprietary dairy cake) were fed on a generous scale, approximately 6½ lb. per gallon in the winter and 3½ lb. per gallon in the summer. From the economic viewpoint this was a sound system of management and costs of production per gallon were low. Total output of milk during the year ending 30th September, 1939, was 14,113 gallons. In addition there were generally a few surplus milking cows for sale during the year, which were replaced by the incoming home-reared heifers.

Other Cattle.

Up to 1937, only cow calves were reared, but the improvement in beef prices encouraged the rearing of a few bullocks which were finished out on the farm. The young calves received a good start in life and were the especial care of the farmer's wife.

Sheep.

The sheep were the only stock not born and bred upon the farm. A flock of some 60 Kerry Hill ewes was kept, generally on the outlying land not grazed by the dairy herd. No attempt was made to sell the lambs fat and they were generally sold at the autumn fairs as forward stores.

Pigs.

A few sows were kept and all the progeny were finished to pork or bacon stage. In this way some 50 to 60 finished fat pigs were sold each year.

The labour consisted of the farmer, his wife, a son about 16, and a half-time man. Except during hay harvest this labour force was well able to cope with the work. Once the stock had been attended, there was ample time for the necessary attention to hedges and grassland.

Generally speaking, farmers of this type were making an income which would compare quite well with what they could have obtained in other pursuits. They were tied by the daily needs of the livestock, but even then could find time to spend a few days away from the farm.

The war brought about two changes in the basic method of grassland dairy farmers, namely, restriction upon the use of imported feeding stuffs and considerable expansion in the area under cultivation. This farmer proceeded to arable cropping with the same determination to get the best out of the land, as he had given to getting the best out of his dairy cows. There were two reserves to call upon, firstly, stored up fertility in the grassland, and secondly, a reserve of manpower. Admitted, the son was reaching that age when he was equal to an extra man, but with the same labour force, or rather less, since hired help was not so easily obtained, this family produced arable crops, wheat, oats, potatoes, and sugar beet for sale, some kale and mangolds for the dairy cows and young stock, while oat-straw helped out the hay supplies. The quality and yield of these crops have been above average. By 1942, the acreage had increased to 109—52 under grass and 57 under the plough. Stock had to be reduced. Early in 1941, the dairy herd was reduced to 5, and is being gradually built up as heifers come into the herd—by the spring of 1942 the herd had increased to 12. During the year ending 30th September, 1942, the total output of milk was 7,550 gallons, an average yield per cow

of 640. Young stock had not been reduced greatly. The ewe flock was maintained at 60 until 1941, but was reduced to 36 in 1942. The pigs were drastically reduced soon after the outbreak of war. Lavish use of purchased foods was the key to production before the war—but by 1943 this farm was producing corn crops for sale, and in relation to its size, was still producing considerable quantities of milk, making economical use of the foods available. Further, it was a source of cows of a high yielding strain capable of making good use of feeding stuffs on other farms.

Throughout, the best, commercially, were bought, whether foundation breeding-stock, sires, foods or seeds. The aim was always to produce high yields of good quality, whether accredited milk, bacon, corn, or potatoes. The stock, and later the crops, had that care which comes of a keen personal interest in their everyday welfare such as is found on the successful family dairy farm.

These family dairy farms rely entirely upon the profits from farming for their expansion. The monthly milk cheques enable all expenses to be met monthly so that there is but little demand for credit facilities beyond the monthly account. There is a common fund into which all the farm receipts are put, and from which all expenditure both personal and farm is drawn. Too often the farm comes first and expansion is obtained to a considerable extent by the restriction of personal expenditure. If there was a son, he worked for clothing, keep and pocket money, the last often supplemented by keeping a few stock upon the farm or by outside work. When the time came for him to set up upon his own account he would take his accumulated wages partly in cash and partly in stock. In fact, all grass dairy farming was a self-contained financial unit, providing not only working capital but also—by saving from profits and by restriction of personal expenditure —accumulating capital which was re-invested, either by the expansion of the original unit or by the setting up of fresh units by the next generation.

SMALL DAIRY FARMS IN INDUSTRIAL AREAS OF YORKSHIRE

DESCRIBED BY

H. I. MOORE, M.Sc., Ph.D., N.D.A., Dip. Agric., Cantab.

In the neighbourhood of many of our large industrial towns agriculture, though taking second place to industry, is actively pursued. Amidst the grime poured out by countless large and small chimneys, with land criss-crossed with footpaths, perhaps on very unkind soil, under innumerable difficulties peculiar to urbanism, these farmers have developed as intensive a system of farming as can be found perhaps in any part of the country. The conditions are neither happy nor congenial for farming, but there is compensation in the fact that the market for the produce is on the doorstep. The appetite of thousands of mill workers, clerks, tradesmen and a host of others is insatiable for the milk, eggs, pork and vegetables from these farms.

Most of the industrial areas are situated on relatively poor soil, such as the Coal Measures and Millstone Grit formations give rise to, and lime and phosphate deficiencies are fairly common. Added to this, the acid fumes of the industries are deleterious to plant growth, and in 1939, practically the entire grassland of such an area was in appalling condition. But this was not considered a serious matter because imported foods such as linseed, cotton, and earthnut cakes were both plentiful and cheap. To balance these protein rich foods there was an abundance of maize and millers' offals and it was a simple matter to construct a balanced ration which would produce a gallon of milk for every three and a half pounds fed. When the grazing in summer, or the hay in winter fell short of expectations, a ring on the telephone would bring more concentrated foods in to the barns to make good the deficiency. Small wonder that farmers in the district had come to regard their grassland merely as an exercise ground for the cattle. As for pigs and poultry they were fed entirely on purchased foods, being crammed to capacity and were so thick on the ground that disease control had become a serious problem. Such arable land as existed was mostly plough-sick, weed ridden and full of disease organisms. In many cases the chickweed grew so profusely that the crops were smothered, or finger-and-toe disease prevented the growth of swedes, or lime deficiency resulted in crop failure. In the market garden areas a more careful watch on the condition of the soil was maintained and large quantities of industrial waste, shoddy, sewage, and ashes were used annually to keep up the fertility.

The majority of these farmers specialized in milk production, and in the years immediately prior to the war hundreds of cowsheds were modernized and every effort made to produce high quality milk. Most of the men practised what is termed " the milk and feed " system which entails feeding the cows with sufficient concentrated food, not only to produce the milk, but to put on flesh at the same time. At the end of the lactation the cows were sold fat to the butcher. In this way depreciation of the stock was kept at a minimum. Others kept the cows for a lactation only and then sold them as " dry " or " laying off " to farmers in grassland areas who bulled them and kept them until they calved again, when they were sold in the open market as newly calven.

In the industrial belt, rents are high and average 50/- to £4 per acre, an average size farm

being in the region of thirty to forty acres. Few of these men, notwithstanding the shocking condition of both arable and grassland, carried less than a cow to the acre, and it was by no means uncommon for a man with twelve or so acres to milk twenty cows.

In the dark days of the depression these men managed to carry on fairly well, but when war broke out and self-sufficiency became the key note of farming the position appeared hopeless. It is obvious that such very high-stocking is impossible under self-sufficiency conditions and many herds have been reduced. The policy of ploughing out appeared at first to be wrong, and there was much opposition to it, but it is now readily acceded that without the plough most of these men would be out of business and the land derelict.

Let us see how they have tackled the problem. Marrow stem kale has proved of great value. It is a crop which responds to liberal manuring, and there is an abundance of dung on the small dairy farm, and crops of 25 to 30 tons per acre are common. Usually one-tenth of an acre per cow is grown and this provides a good daily ration from September to Christmas. Oats do well on ploughed out grass even when the lime content of the soil is low, and this has been a favourite crop; one quarter of an acre per cow being the usual quota. The oat straw is fed in conjunction with kale as a maintenance ration up to Christmas. From then on, hay perhaps with some silage has sufficed for maintenance and a gallon of milk at least. By now the system of farming is fairly standardized, and, where the area of land permits, the following allowances per cow are made:—Kale $\frac{1}{10}$th acre, roots or silage $\frac{1}{4}$ acre, oats $\frac{1}{4}$ acre, seeds for hay $\frac{3}{4}$ acre, and seeds for grazing a further $\frac{3}{4}$ acre, giving $2\frac{1}{10}$th acres per cow in all. Assuming average yields these acreages will supply all the cow's needs for maintenance and the production of two gallons of milk.

The ploughing out and direct re-seeding of poor grassland has contributed to the solution of the urban farmer's stocking problem more than any other single factor. A large area has now been treated in this way with phenomenal results. In general it has been possible to commence grazing some six to eight weeks after seeding, and an increase in the milk yield has been noted as soon as the stocks have been turned on to the new swards, this usually amounting to about half a gallon per head per day. In this way a good deal of the initial cost of the work, which is in the region of £10 10*s*. per acre, has been recouped in the first season. For instance, on one farm within the boundary of the City of Leeds, a matted, bent sward of negligible stocking capacity was ploughed in April, 1942, re-seeded in May and first grazed on July 13th. At the first grazing 39 cows were on the 8 acres for 12 days, and during this period the milk yield increased by 15 gallons daily, bringing a total cash increase of £27. The cows subsequently grazed the field for two further periods of 10 days and 15 days, and the farmer obtained in additional milk £78 on an outlay of £67 for the re-seeding.

Silage has also been extensively adopted, using cereal-legume mixtures and aftermath grass. As leys are becoming established the output of silage tends to increase, and dairy farmers in the area truly regard it as a sheet-anchor for their winter milk production. The policy of ley farming has been abundantly justified throughout the industrial area, so much so, that in one case on a poor Millstone Grit farm in the Hebden Bridge district of West Yorkshire, one man to-day is producing 75 gallons of milk daily from 27 cows on 34 acres of land. This is by no means an isolated case and gives some impression of the measure of self-sufficiency that has been attained where formerly complete reliance was placed on purchased food. What is more, this accomplishment has come in the short space of three years, and has been achieved by men with no previous experience of arable farming.

As to pigs and poultry, these have quite naturally been drastically reduced, and in cases where the farmer specialized in one or the other before the war, much hardship has resulted. In the case of pigs the position was somewhat alleviated by the use of town swill. Many also eked out the meagre supplies of poultry food by feeding the better class swill.

One naturally wonders as to the future of these small farms. They are changing rapidly; the grassland is immeasurably improved, the technique of ploughing up, and of ensilage is being acquired on a large scale, and there is every prospect that, whatever the future holds for farming, these men will carry on, since milk is the prime product. It is likely that milk products will be consumed in ever larger quantities, and when the consumer is on the doorstep of the farm its freshness can be assured. Moreover, the system of farming is such that women can assist greatly in the work, should the labour shortage remain acute, and the problem of machinery has been solved through the medium of the County Committees.

A SMALL ARABLE FARM IN SOUTH-WEST LANCASHIRE

DESCRIPTION BY

J. J. GREEN, B.Sc.

EXCEPT for labour difficulties and the consequent necessity for greater mechanisation of farm operations, the war brought little change in farm practice on the typical south-west Lancashire arable farm. Pre-war, the amount of permanent

grass was reduced to the minimum necessary to provide, near the homestead, grazing for the horses. Replacing horses by tractors he was able to reduce still further this small proportion of pasture. One change the war brought about. Keeping no live stock except horses, and possibly pigs and poultry, the fertility of the soil was maintained by the purchase of farmyard manure from grassland dairying districts. These dairy farmers now required for their own arable land all the manure produced on their holdings. To maintain soil fertility the arable farmer had to keep live stock, at least during the winter, in order to convert his home-grown straw into manure and probably also graze some of the leys instead of taking a hay crop.

The typical farm is about 70 acres. The soil is light, varying according to district, or even on the same farm, from sandy loam to "moss," i.e. reclaimed peat land. It is invariably deficient in lime, but where reasonably well manured and limed, gives excellent crops of potatoes, wheat and oats. There is a good market for potatoes in the neighbouring industrial centres.

A really well-farmed example of this class of holding inspected in August 1942, is described below.

This 42-acre holding on the black moss land was cropped and worked by the owner-occupier, his three sons and their women folk, all of whom worked very long days. They had a tractor and a two-horse team which enabled them to get the work of their own farm done expeditiously and early, and to render assistance to less well-equipped neighbours.

Potatoes and oats each covered between 16 and 17 acres. Early potatoes were not grown because of the risk of frost damage on this land, but 12 acres were devoted to King Edwards and the remainder carried Dunbar Standard, Majestic, and a few Arran Banners. All the potatoes were good and the King Edwards which were grown from Scotch seed were very much above the average. Except for a small area of Star, the oats were of the variety Marvellous, a name which seemed particularly apt, for a heavy crop of corn was standing without a single laid patch.

Two acres of peas were inter-cropped with celery, savoys, cauliflowers and sprouts. There were also 1½ acres of onions—amongst which the variety "Up-to-Date" made a particularly good show—an acre of sprouts and half an acre of beetroot.

The headlands running up to the dykes or roads that marked the boundaries of the farm, were all planted with turnips, lettuces or other useful crops. In various nooks and corners vegetable marrows were established. Early mint propagated in a small enclosure had proved to be an exceptionally profitable venture, and in a small greenhouse, tomato plants which were heavily laden with trusses of fruit, were following two crops of lettuce. The remaining two acres were cropped with ryegrass and clover, to be ploughed immediately the first cut had been harvested, and the land planted with savoys and cauliflowers.

Except for the two horses and 70 head of poultry, there was no live stock upon this neatly kept and most productive holding.

A HILL FARM

DESCRIBED BY

H. I. MOORE, M.Sc., Ph.D., N.D.A.,
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There is romance in hill farming. The boundless sweeps of heather-clad moors or shaggy fells, the stillness, the steeliness of the air, the occasional bleat of a ewe, the shrill whistle of the shepherd, the wisps of smoke twirling above the clustered houses of the village, the red glow of the sun behind the hills. There the romance ends—the rest of the story is about hard work.

Statistics for England and Wales show that in 1939 out of a total area of some 37 million acres there was about 5½ million acres of rough grazing. A good deal of this land, though ploughable, is given over to sheep and hardy cattle because of its inaccessibility, lack of adequate water or fencing, or due to the lateness of the season.

The soil is poor owing to the leaching action of the rain—frequently the rainfall is of the order of 80 inches compared with no more than 25 to 30 in an arable area—and shortage of lime and phosphate are common. Only poor herbage exists under these conditions and *Nardus* (white bent or wire grass), *Molinia* (flying bent) and cotton sedge are the chief constituents. In addition, large areas are covered by heather and bracken, the latter especially being very troublesome, for it encroaches upon the better quality herbage. When allowed to spread it not only chokes out the better species but forms cover for ailing sheep, which, seeking seclusion in the tangled mass of growth, are lost to view and cannot be seen by the shepherd on his rounds. Only by drastic and persistent action is eradication possible, and cutting twice a year is essential. Ploughing followed by a crop rotation is a more certain means of control, though practical difficulties with work of this type are often insuperable. In all these areas the plant is cut for bedding. Heather on the other hand, is useful since the young shoots are palatable to sheep. In many of the upland districts anything from one-eighth to a third of the land may be covered by heather, and on these farms a certain acreage is burnt each year to keep the plants small and produce fresh green growth.

A description of a typical hill farm will be of help. The acreage is in the region of five hundred with no more than about twenty acres

of lowland. The rent is £160 per year. Some of the land rising from the lowland can be classed as moderate pasture, but this soon passes into rough grazing. The small area of lowland is usually reserved for meadow hay, yielding about thirty hundredweights per acre. Even more important, it carries the flock during severe weather when it has to be brought from the high ground. Most of the hay goes to the cattle that are kept, but some must always be reserved in case the sheep require it. As a rule, the ewes fend for themselves and even when the ground is covered by snow they scratch it away and find enough to keep them going. Frost soon puts a stop to this and then hay has to be fed. No hill shepherd, however, likes to feed hay unless forced to do so, for once the ewes rely on outside help they lose their initiative in seeking fresh food. As a result of the late grazing of the meadows with sheep, hay-time is seldom possible before late July or August. The crop is usually stored under cover in stone barns which frequently house the cattle as well.

The farm described carries 250 ewes ranging in age from five to six shear and one ram to every 50 ewes is allowed. The rams are put to the ewes in November, for in these exposed districts early lambs are not wanted and it is much better for them to arrive in April when they can go out with their mothers on to the high land. The ewes are always left on the hills as long as possible and should the weather be favourable will lamb there also.

The flock is dipped three times a year. Prior to lambing a powder dip is used to free them from insects which would infest the lambs, and it also provides an opportunity for any loose wool around the udder to be removed. If this is left and the lambs swallow it, wool balls are formed in the intestines and death follows. A carbolic dip is used in August, for this acts as a deterrent to the blow fly which is a serious pest, and the third dipping comes just before or after tupping. On this occasion an oily dip is used in order to make the fleece weather proof for the winter.

Lambing is undoubtedly the most anxious time of the year on a hill farm. The ewes must be inspected frequently to see how the lambs are faring. Twins may have to be parted, and one lamb put to a ewe that has lost its offspring, for hill sheep seldom have sufficient milk for two lambs; some lambs will need suckling; some ewes will require assistance in lambing; others will have to be taken home for special care. Trying as these abnormalities are, the whole task is doubly difficult when the weather is bad, and during snowstorms is even hazardous, the shepherd often risking his life in efforts to save members of the flock from snowdrifts.

Lambing over, the flock is marked with the owner's stamp and turned on to the moors. An average fall of one lamb per ewe is considered good, and losses frequently bring the average considerably below this. The flock is not gathered again until July when shearing takes place and they are re-marked.

Forward wether (male) lambs are sold in August, and the main batch in September, when in these districts large sales are held, to which lowland farmers come to purchase lambs for fattening on roots during the winter. Working on a five-year basis about fifty ewe lambs are required each year to maintain the flock, and after these are selected the surplus ewe lambs, together with the draft ewes, are sold. The ewe lambs cannot withstand the rigours of winter in the hill districts, hence in November they are sent to a lowland farm. Here they can get better grass and perhaps some hay. They stay until the end of April when they are brought back and turned straight on to the hill until clipping time. The cost of "wintering abroad" is in the region of 12/6 to £1 per head.

Sheep constitute the mainstay of hill farming, but cattle-rearing is also practised especially as the type of calf is usually good, and at the age of six months commands a good price. Many prefer to keep them, however, until they are three years old and sell them as down-calvers. Usually three to four cows are kept and are allowed to suckle their own heifer calves for about four weeks. The calves are then weaned onto gruel and newly-born heifer calves are bought to replace them. In this way each cow rears about eight calves per year. About half of these will be sold at six months old, but the most promising are retained. In addition to the three cows, therefore, the farm carries some twelve yearlings and twelve two-year-olds. After calving the heifers are sold and their calves put on to the older cows. Down calvers in 1939 were fetching in the open market about £20 apiece. The majority of these men have a reputation for their stock and purchasers are invariably waiting; indeed, many of the milk producers in the intensive dairying areas rely on the hill farms for their herd replacements. In the years immediately prior to 1939 when sheep prices were low, many hill farmers turned over to milk production, which was not only more profitable than rearing, but brought in a monthly cash return. Moreover, cakes and meals were plentiful and cheap, and the deficiencies of the grassland could be remedied very easily.

The problem of labour in these areas in normal times is fairly simple, since on a farm of the type under review, one hired man to look after the cattle is all that is required. The farmer himself generally takes charge of the sheep whilst his wife is responsible for the calf rearing, and any poultry that are kept. At busy times like shearing and hay-making it is usual for neighbours to lend a helping hand, they in turn receiving help when required.

Capital outlay is relatively low compared with say an arable farm of comparable size, because the tenant-right valuation is low, and costly and

elaborate machinery is not necessary. To offset this both capital, turnover and output are low. For instance, on this farm in 1939, fifty draft ewes were sold for 22/- each, 125 wether lambs for 16/- and 75 ewe lambs for £1 each. Twelve down calvers averaged £20, and the wool brought in £50. When the rent, the cost of wintering the ewe lambs, a man's wages for the year and a cake bill for £40, besides a number of small items inseparable from farming, are deducted, what is left? As a matter of fact, before the war the best of hill farms, skilfully managed, afforded a moderate profit; the average hill farmer was able to clear expenses; the man on a poor farm had to struggle for existence.

It is true that times have improved on these farms since then. Land has been ploughed in an endeavour to become self-supporting in feeding stuffs. A new technique has been developed for improving the old worn-out grassland by ploughing and re-seeding, silage-making has spread, a subsidy for hill flocks, and more latterly for cattle has, and will, encourage the hill man. There is certainly vast scope in all hill areas for a tremendous improvement in the stocking and cropping capacity of the farms. Capital and initiative are essential, but these are insufficient without a forward national policy and assured and remunerative prices for the farm produce.

A HEREFORDSHIRE FARM

DESCRIBED BY

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COUNTY AGRICULTURAL ORGANIZER,

AND

C. KINSEY

A MIXED farm of 280 acres, this holding was up to 1939 typical of much of Herefordshire. There were then 166 acres of old permanent pasture, 14 acres of ley, 35 acres of grass orchards and 65 acres of arable land.

Hereford cattle are a distinctive feature of the farms of the district. On this farm a herd of 32 pedigree Hereford cows were kept in 1939, and the farmer, like many others, has shown his confidence in the future of these grand cattle by maintaining the herd at its pre-war strength. Half the herd are autumn calvers, the other half calve in the spring. The spring calves are weaned at six months old, the autumn calves at four months old and their dams suckle a second calf which is purchased. All the cows are out-wintered, their ration consisting mainly of roots and straw with a small amount of hay. Very little concentrates are fed except to part of the autumn calvers.

As many stock as possible are yarded during the winter in order to convert straw into muck for the arable land, and it is notable that on this farm there is no surplus straw problem, in spite of the increase in the corn acreage during the war. At the time of writing, the whole of last year's straw had been consumed or trampled into muck; a fact which partly accounts for the high yields obtained. All the spring calves and a large part of the yearlings are wintered in the yards, their rations consisting of hay, straw fed *ad lib*, roots and home-grown concentrates—oats and beans.

Each year a proportion of the best heifers are saved for breeding purposes. Up to 1941 the remainder, together with cull cows, were fattened off on the farm, part on the best pastures during the summer and the others in the yards on roots, straw, hay, and concentrates during the winter. As regards concentrates in 1939, part of these were home-grown and part were purchased oil cakes. With the decrease in the supply of purchased foods and the reduced area of permanent pasture it has not been possible to fatten all the surplus stock during the past two years, and part of the surplus has been sold as strong half-fat stores for which there has been a good market. But, and this is very important, as the long leys which have been sown become available more stock can be carried and the farmer hoped that in 1944 he would be able to finish nearly all his fat animals—this, in spite of the large proportion of the arable acreage allotted to priority crops.

The number of cattle carried on the farm was:—

	1938–39	1942–43
Pedigree Hereford cows and heifers	32	32
Cattle under one year old ..	22	21
Yearlings and two-year-old cattle	60	50
Total	114	103

Sheep are a useful, though minor section of the farm. A flying flock of 56 Clun cross-bred ewes was kept in 1939 and now that the long leys have become established the number has been raised to 121. The ewes, which receive but little concentrates, are wholly grass-fed. After lambing they are transferred to long leys. Teg-feeding on roots—a common practice on light land in this district—is not carried out on this farm because of the heavy nature of the soil. The store lambs are sold in the late summer sale.

The arable land has always been a comparatively important unit. Between 1939 and 1943 the area under the plough was doubled and the area under priority crops increased from 25 acres to 86 acres. Normally the farmer does not grow barley, as the soil type is not, in his opinion, eminently suited to that crop; but when that

became a priority crop he grew barley on 20 per cent of his arable acreage. This is rather typical of him in so far as he is one of those farmers who did their utmost to make their farms help feed the nation during times of emergency.

The cropping of the arable land was:—

	1938–39 acres	1942–43 acres
PRIORITY CROPS		
Wheat	25	53
Barley	—	25
Potatoes	—	4
Sugar beet	—	4
Area under priority crops..	25	86
OTHER CROPS		
Roots	16	18
Oats	24	10
Beans	—	7
	65	121
LEYS		
1 year	14	15
3 years	—	36

Prior to 1941 only one-year leys were cultivated, but in that year a three-year ley was introduced, and the policy was immediately found to be an unqualified success. In all cases mixtures consisting partly of pedigree and partly of commercial seeds have been sown. By 1943 there were 36 acres under long leys, and the farmer had satisfied himself that the results obtained from them were superior to those obtained from old permanent pastures. He therefore proposed ultimately to take the plough round the whole farm which he argued (and we think very rightly) would enable him to produce a large area of saleable crops, and at the same time to fatten his stock without recourse to imported cakes.

The staff in 1939 was five permanent men and this, under changed conditions was only augmented by one boy and one land girl. It was possible to cope with the increased work without any very great increase in the amount of labour employed, owing to the increased use of machinery; but it should be pointed out that the result was that his staff was strained to the limit of its capacity in spite of the fact that a good deal of casual labour was employed for certain crops such as sugar beet and potatoes.

This farmer is a progressive up-to-date man. He sought technical advice and put it into practice as part of a policy of consistent and steady improvement. Consequently, the holding reached a high state of fertility—in 1942 his wheat averaged 30 cwt. per acre, and potatoes 15 tons per acre, and it is notable that the saleable output which in 1939 amounted to approximately £2,500 was within a few pounds of £5,000 in 1942.

A COMMERCIAL POULTRY FARM

DESCRIBED BY

ADRIAN T. MONCK-MASON

THE poultry farm described below belongs to an ex-Service man who took up poultry-keeping in 1919. He did not undergo any special instruction, but started in a small way with seven fowls, building up gradually as he acquired experience.

The farm, which is 32 acres in extent, is situated on the top of the North Downs, and has a medium soil which drains freely. The present farmer has been in possession since 1929, and kept poultry on the intensive system until war conditions made it necessary for him to reduce his stock. Previously the land had been used as a poultry farm for ten years.

Prior to the war the business of this farm was commercial egg production, and 600,000 eggs were produced annually. The whole farm was under grass. An area of ten acres was laid out for rearing; here 15 arks and 28 rearers were used. The remainder of the farm was divided into 42 inter-communicating pens, each of which was equipped with an intensive house accommodating 100 birds. All the houses and runs and the main part of the equipment was constructed on the farm by the farmer and his men. The cost of this home-made equipment was less than one-third of the purchase price of similar ready-made appliances.

The 1939 stock was 3,000 Black Leghorn-Rhode Island birds. Here cross-bred fowls are always used for egg production. Considerable importance is attached to the selection of stock, but no preference is shown for any particular breed. The practice is to analyse the results obtained in egg-laying trials, and to keep a careful watch upon the stamina of the popular breeds. Each year the birds required for the breeding pens are selected from the breeds which available data indicates have the highest stamina.

Pullets for the breeding pens are reared from specially-selected purchased sittings of eggs. They are mated with the best cockerels obtainable, which are also purchased.

The 1939 staff was three men and two boys. It is pointed out that labour charges, which under the most favourable conditions are a serious item in the profit and loss account of a poultry farm, may, if not carefully controlled, become so high as to swamp any possible profit. Therefore on this farm, labour-saving appliances are used to the maximum extent, and the work so organized as to reduce to a minimum the number of operations which have to be performed at regular intervals.

On war-time rations it was found impossible to continue commercial egg production; instead, day old cockerels were purchased, fattened upon rations consisting mainly of vegetables and

potatoes, and sold at an average weight of 4 lb. Only 3 acres were required for these birds which were shut up to fatten, so the wire was taken down and the runs ploughed and planted with arable crops.

A PIG FARM

DESCRIBED BY

THE AUTHOR

THIS farm is located on the side of the North Downs, and in 1939 consisted of sixteen acres of poor pasture. The soil is a thin loam overlying the chalk. It drains readily, carries very little grass in dry weather, and puddles badly if stocked with pigs when wet.

The pig farm was started in 1921 at a time when the open-air system of pig-keeping was being advocated by many enthusiasts, and in the first instance it was worked on that system. Farrowing pens for the sows were constructed, each equipped with a portable hut and a grass run of one-tenth of an acre; these pens were fenced with hurdles and were moved on to fresh land every other year. The remainder of the land was divided into large pens to accommodate in-pig sows, gilts and store pigs. A number of gilts were retained each year for breeding, and the remainder of the young pigs was sold shortly after weaning.

This system was found to have two disadvantages. Firstly, rearing young pigs in the out-door runs was simple and fairly convenient during the summer months, but it was found to be unsatisfactory during the winter and early spring. At that period of the year the small runs got too badly puddled to provide satisfactory accommodation for young pigs. Secondly, although weanyer pigs usually realized profitable prices, there were times when the prices were unremunerative. Therefore a set of permanent farrowing pens, and a modern fattening house were erected.

Subsequently the sows were farrowed in the permanent farrowing pens, being allowed out to graze in an adjoining run when the ground was firm. The young pigs were confined to their farrowing pens until after weaning. During the summer months pigs reared in this way did not grow so fast as their out-door mates, but it was considered that the saving in labour compensated for the loss in weight. During the winter months the piglings reared indoors grew faster than their out-door mates. The fattening house made it possible to finish a large proportion of the pigs reared, and thus rendered the farm less dependent on the weanyer market.

Two breeds of pigs were kept—the Large White and the Saddleback. All the sows were registered, in addition the piglings were weighed at the age of eight weeks, and a record of the performance of the sows was kept. Gilts were only saved from sows which had good records, the remaining sows were crossed; the Large White sows were crossed with a Saddleback boar because it was considered that the cross-bred piglings were easier to rear than pure Large Whites: the Saddleback sows were crossed with a Large White boar because the cross-bred pigs made a better price than pure Saddlebacks.

In 1938–9 twenty-four sows were farrowed during the winter and thirty-six during the summer months; about 480 pigs were produced. There was a bacon contract for 240 pigs, and sixty were sold on the pork market, the remainder being disposed of as weanyers. In those days the pigs were fed on balanced meal mixtures mixed on the premises.

The war altered all this; thirteen and a half acres were ploughed. Swill was collected from a neighbouring town, and chat potatoes from farms in the district. These, combined with the small meal allowance made to pedigree herds enabled a herd of twelve sows to be maintained so that the herd could be rebuilt as normal conditions gradually reasserted themselves.

THE BUSINESS SIDE

A few business matters are discussed in this section—The Essentials. The first step. Some aids to success: book-keeping, cost accounts, production records. Buying: how to judge value of manures, food, live stock. Marketing. Insurances. The National point of view.

FARMING is a business in which profits are comparatively small, and many successful farmers despite their rugged exterior, and in some cases an apparently simple manner—are shrewd business men, for to be successful in addition to being an expert husbandman the farmer must be able to buy and sell on the most favourable terms, to manage labour efficiently, and to organize his farm so that production costs are low, and that products which will command a profitable price are available for sale.

The Basis.

The foundation of success or failure is laid when the farm is acquired; for a man who incautiously takes over a farm at too high a rent, or what is worse, saddles himself with too heavy a charge in respect to mortgage interest, starts with a serious handicap which may easily prove too much for him.

Cost of upkeep is another item which needs watching; here the most important item is usually the charge in respect to buildings. The cost of maintaining over-elaborate buildings, or light, cheap or dilapidated structures may prove to be an insuperable burden to an owner occupier or a farmer with a repairing lease.

The allocation of working capital is another matter requiring judgment and restraint, for the tendency is to take the largest holding possible—a tendency which, I for one, do not feel disposed to criticize—and this usually means being short of working capital. In that case the golden rule is spend comparatively liberally on productive items, such as crops and stock, economizing on non-productive items—buildings and equipment.

Some Aids to Success.

With a business like farming in which profits are small and prices liable to fluctuate, a constant watch must be kept on finances, and simple but accurate accounts should be kept on every farm. Conditions which are adverse for one department of the farm often favour another—for example, in a wet July and August corn crops are liable to be laid, with the result that the grain is of inferior quality when threshed—containing a large proportion of discoloured kernels and tail corn; but pastures will be abundantly supplied with grass and as a consequence grazing stock do well and cost but little to keep. Therefore the farm should be judged as a whole, and the criterion of success or failure is the Profit and Loss Account.

It is, however, desirable to analyze the profit and loss account annually, and to ascertain the extent to which each department and even units of departments, are contributing to the well-being of the farm. A department, or a crop or some given category of stock, may, and frequently does, lose money in one, two or even several years without causing undue alarm *if the loss is due to a factor having a temporary adverse influence* such as bad weather or a temporary depression of prices; but if a department, crop, or some category of stock is losing money and there appears to be every prospect of it continuing to do so, either production costs should be reduced or the unprofitable unit discontinued. Cost accounts are necessary to enable the profit and loss account to be analyzed.

Some farmers have their own method of costing and are able to form an estimate of their own production costs which they consider to be sufficiently near for practical purposes; but their methods are rough as compared with those employed by an accountant, and the more accurate this work the greater its value. There can be no question of the value of accurate cost of production figures, and on some of the larger farms, a costing clerk is kept to do the work.

Production records are of the greatest possible assistance to those breeders of livestock who have other interests, and find it difficult to remember all the details of individual animals.

Milk Recording—that is to say, practice of keeping records of the milk yielded by the individual cows in a herd, is by far the most important of the production records. Fostered by the Ministry of Agriculture, there are now milk recording societies in all parts of the country, whose work is to compile and certify the records of the cows in members' herds. It must always be remembered that milk recording is only a means to an end—the object of recording a herd is to enable the herd to be graded up and the average milk yield of the cows improved. If the objective is to be attained a careful watch must be kept on records, indifferent milkers must be quickly culled, and heifers only saved for the herd from good milkers. Generally a marked improvement can be effected in the average milk yield in the two or three years which follow the introduction of milk recording into a herd. This is due to culling of bad milkers; but once the worst milkers have been got rid of, further improvement is bound to be slow. Here it may be pointed out that if calves are to be good milkers, both sire and dam must be selected for milk. Thus the results obtained from milk recording are likely to be disappointing *unless a good dairy bull is used in the herd.*

Closely rivalling milk recording in importance are egg-laying tests. Official trials have now been conducted all over the country, and in addition many breeders use trap nests and record the performance of their best strains. By the

systematic use of egg-laying tests the laying capacity of our best breeds has been materially improved during the last decade, and to-day there are a large number of strains of birds in commercial flocks with a proved egg-laying capacity, and the ability to transmit it to their offspring.

There can be no doubt of the value of pig-recording, a practice which had to be discontinued upon the outbreak of the Second World War. Pig-recording is designed to test and record, both by individuals and by interested societies, the litter-raising capacity of sows. In 1939, there were already many breeders who were keeping their own private records of the performance of their sows and a few societies had already started to record and certify the records of sows in the herds of their members.

Buying.

On many farms a considerable amount of money is expended annually upon such things as manures, feeding stuffs and livestock, and profits are materially influenced by the prices paid.

It is an easy matter to compare the value of manures on the unit value basis. The unit used is 1 per cent of 1 ton of the various manurial ingredients, i.e. of nitrogen, phosphoric acid and potash. The unit value of a simple manure such as sulphate of ammonia is calculated by dividing the price per ton by the percentage composition. The unit values ascertained from the simple manures can be used to calculate the value of a compound manure.

It is a rather more difficult matter to compare the value of feeding stuffs, because several are invariably mixed together and the criterion is the cost of the mixture rather than that of individual constituents. Here the simplest method of procedure is to work out a number of mixtures from available foods and compare the value of equivalent quantities. The following illustration will show how the method works. Here are two milk production rations:—

No. 1.—1 part by weight bean meal.
2 parts by weight crushed oats.
½ part by weight decorticated ground nut cake.
Of this mixture 3½ lb. are required to produce 1 gallon of milk.

No. 2.—5 parts by weight flaked maize.
1 part by weight linseed cake.
4 parts by weight decorticated ground nut cake.
2½ lb. of this mixture are required to produce 1 gallon of milk.

Now 3½ parts by weight of No. 1 are equivalent to:—
2½ parts by weight of No. 2.

When the cost per ton was No. 1, £6 15*s.* 0*d.*, No. 2, £8, 3½ tons of No. 1 would cost £23 12*s.* 6*d.*, and that is equivalent to 2½ tons of No. 2, costing £20 0*s.* 0*d.* The latter being the better value.

Very considerable sums of money are often expended on the purchase of live stock, and the price is almost invariably the major factor in the cost of production of the ultimate product. There will be no chance of an animal earning a profit if the initial price paid is unduly high. The main points which must be taken into consideration in this connection can be seen by following the mental arithmetic which is worked out in the mind of a keen buyer, of three different types of animal.

Let us take as our first example, a farmer bidding for a bunch of beasts. This is how he will work them out: " Their average weight is 8½ cwt., their condition good, and I can get them out in 16 weeks, during which they will put on about 1½ cwt. That is to say, they will be ready to market in February, and should then have an average weight of 10 cwt., being worth £37. They will cost me 12/- per week, i.e. £9 12*s.* 0*d.*, and to this £1 must be added—carriage to the farm, and the same amount back to market, plus 10/- for incidental expenses, £12 2*s.* 0*d.* in all. So that the price must not exceed £37, minus £12 2*s.* 0*d.*, i.e. £24 18*s.* 0*d.* per head, or a loss will result."

Now let us consider the case of a man bidding for in-calf heifers, and here it must be pointed out that different men work in different ways. The man to whom I was apprenticed would work things out like this: " Heifers usually last 6 years and are worth £10–£15 at the end of that time: that means that a heifer which to-day costs £45 will depreciate £30 whilst in the herd. That is £5 per annum, and if she gives an average annual yield of 800 gallons, which is a high average, that means 1½*d.* on each gallon of milk for the depreciation of the cow, and that is a comparative high charge." None the less, he would sometimes pay even more for a specially good animal from which he hoped to rear heifer calves.

The subject would be incomplete without reference to the purchase of sires; for their cost is spread out over the herd or flock, and therefore it is permissible to face a comparatively high depreciation. Take for instance the case of a bull for a herd of 40 dairy cows: a bull will usually last three years in the herd, and in that time if all the heifers are reared and sold in-calf if not required for the herd, he will have 180 services. If he costs £180 it represents £1 per service; rather a high figure, it is true, but one which may be necessary to secure a bull sufficiently good for a herd of heavy milking cows.

Marketing.

The value of collective marketing is now fully realized in this country, and in spite of the fact that all schemes were in the " teething stage," impartial observers agree that those for marketing milk, potatoes, hops, and bacon pigs, contributed greatly to the well-being of farming prior to the war.

Whilst the general price level is governed by world markets and/or political considerations, there is always a certain amount of variation in the prices of different grades of farm produce; and in the case of products for which there is an open market the prices ruling in different parts of the country sometimes differ. Quite frequently these price variations are a very material matter, and the ability of a grower to secure the top price may make the difference between profit and loss. A simple example illustrating this point occurs with pigs. A five-score pig is worth (March, 1943) 21/- per score, and a seven-score pig 24/- per score; comparing the returns from the production of 35 scores of meat in the two cases we find that seven pigs weighing 5 scores will realise £36 15*s*. 0*d*. whereas five pigs weighing 7 scores make £42, i.e. 14 per cent more, and this in spite of the fact that a 7 score pig costs less to produce *per score* than does a 5 score pig.

Thus a farmer must keep a careful watch on market conditions and be prepared to adapt his system of farming as may be necessary, to enable him to produce what will sell best, and to place his products on the market at the right period of the year.

Insurances.

A considerable amount of care and thought is required each year before placing insurances. To be under-insured is often a fatal mistake, but premiums come to an appreciable amount, and it is waste of money to over-insure.

Before the first man commences to work on a newly-acquired farm, a cover for Employers' Liability should be obtained, and this cover must be constantly maintained so long as anyone is employed. No motor vehicle must be allowed to go on the road unless covered by a third-party liability insurance, and it should be noted that this policy is only valid if the vehicle is driven by a driver holding a valid licence. Each week, Insurance Stamps must be duly affixed to the card of every person employed. A fire insurance policy is also essential.

There are some who insure regularly against hail. A variety of insurances are available for stock, the two which are most held being those covering in-foal mares and stock in transit.

The National Point of View.

The nation has a very direct interest in agriculture for three reasons. Everything produced on our farms is a direct addition to the national wealth, and that, to a country impoverished by two major wars in the brief period of twenty-five years, is an all important matter. The largest industry in the country—agriculture—if prosperous can make a substantial contribution towards solving the unemployment problem. A well organized agricultural industry is the country's only insurance against famine in time of war.

Cabinet Ministers have said that never again must agriculture be allowed to decay, and in doing so have echoed a sentiment which was widespread throughout the country in those years of trial, 1940–1945.

Reference has already been made (page 3) to the fact that agricultural wages and the standard of farming that now prevail cannot be maintained if the prices of agricultural produce are allowed to fall to pre-war levels. This does not mean that war-time prices must be maintained, in most cases an intermediate figure would suffice. The question naturally arises, what will it cost?

The problem is very complex because of the varied nature of farming. General farms cover a large proportion of the land, so that it is desirable to maintain arable land and stock on an economic footing, whilst the interests of milk producers, market gardeners, and fruit growers must be considered; but some idea of the magnitude of the problem can be formed from a study of the case of wheat.

When the price of wheat was 8/- per cwt. agriculture was a depressed industry. Before the war the price was stabilized at 10/- per cwt. That made wheat production an economic proposition on suitable land. Agricultural wages which were at that time about £2 per week, have now been raised to £3 3*s*. 0*d*., so that if under peace conditions wages are to be kept at the latter level, the price of wheat should be at least 12/- per cwt.

Leaving out the question of all subsidies; with wheat at 8/- per cwt., a four-pound loaf costs fourpence halfpenny; other things being equal if wheat is 12/- the loaf costs sixpence.

The average person eats half a pound of bread per day, i.e. 3½ lb. per week. This would cost:—

4 with the loaf at fourpence half-penny.
5¼ with the loaf at sixpence.

It will be seen that if we produced the whole of our bread corn without any subsidy, the difference between a depressed and a healthy wheat growing industry would be the equivalent of *one penny farthing per head of the population per week.*

It would be a bold man, who at the time of writing, was prepared to forecast what the price of the staple food commodities will be on the world's markets in years to come. It is certain that several years will elapse before they become even approximately stabilized, and it is unlikely the price of wheat will again fall to 8/- per cwt., for the simple reason that none of the great wheat producing countries regard that as a satisfactory price. *So that the odds are very great that it will not cost so much as the equivalent of one penny farthing per head of the population to maintain wheat growing in this country in an economic condition.*

SCIENCE AND FARMING

In this section the way science has aided farmers in their war effort is cited to indicate some of the directions in which science can assist the farmer. The Advisory Service is explained.

AGRICULTURAL education works so quietly that the results obtained by scientists are often absorbed by the industry without the source from which they come being appreciated. Even before the war, owing to the combined efforts of those engaged in research and education, all the discoveries of science that were of practical use were being utilized by the more advanced farmers. The war gave a great impetus to the application of scientific findings, and to-day the general run of farmers are following the example of the more advanced men. That was one of the factors which made possible the war-time increase in the food production of this country.

Merely to outline the uses of science would be pointless; but the outstanding examples in which science has assisted farmers in their war effort may be cited as indicating its value to the industry and some of the directions in which it is most useful.

A very much larger annual output of food was produced in this country during the world war No. 2, than at the corresponding periods between 1914 and 1918. Three factors combined to make the increased output possible:—

(A) The first was that a larger area of grassland was ploughed and put under arable cultivation.

(B) The second is to be found in the fact that whereas an *unduly large proportion* of the crops planted on newly ploughed pasture in 1914–1919 were a partial or complete failure, a high proportion of those sown in 1939–45 produced good yields, and only a small proportion failed.

(C) The third was the introduction of new feeding stuffs for stock and the more efficient utilization of such stock foods as were available.

(A) *The increased area of arable land.*—It was only possible to deal with the larger arable acreage because of the partial mechanization of the industry. That was made practicable owing to the improvements in farm machinery brought about by *agricultural engineers.*

(B) *Good yields instead of unduly large proportion of failures.*—The fact that good crops were produced upon newly ploughed land in 1939–45 whereas many failures occurred in 1914–19 can be largely attributed to the combined influence of four groups of scientists: (1) Agricultural Engineers, (2) Advisory Chemists, (3) Advisory Entomologists, (4) Mycologists.

(1) *The part played by the Engineers.*—Many of the crop failures in 1914–19 were caused by inefficient cultivation and/or late sowing, both being largely due to lack of implements with which cultivations could be carried out *speedily.* During the past twenty years *agricultural engineers* have made enormous improvements in agricultural tractors and tractor-drawn implements. With the improved machines cultivations can be carried out quickly and at the same time efficiently. As a consequence, whereas in 1914–19 crops often had to be sown late upon land that had been imperfectly cultivated, now even the increased acreage can by comparison be efficiently cultivated and prepared for seeding in good time.

(2) *The part played by Advisory Chemists.*—Soil deficiencies were a constant cause of crop failure in 1914–19. Such deficiencies cannot be detected by eye, and during the first world war farmers had no means of ascertaining whether or not the soil of a newly ploughed field would produce satisfactory crops. During 1939–45, the Ministry of Agriculture provided Provincial Advisory Chemists with the necessary laboratory accommodation and staff to enable them to analyze soils for farmers. A large number of the samples submitted for analysis were found to be deficient in lime. In an appreciable number of cases deficiencies of available phosphates and/or available potash were also discovered, and in them the analyst's report enabled the farmers to correct the deficiency. Here is an example which shows the value of these analyses:—

A sample of soil was submitted for analysis accompanied by the following note:—" This soil comes from a well-drained field which was ploughed from pasture in 1940 and cropped with wheat which failed; in 1941 it produced a good crop of potatoes, but the 1942 crop of oats failed. I want to grow barley in 1943 and to sow a three-year ley seeds mixture under the corn." The soil was analyzed and the report on it was as follows:—" pH. 4·5. Very acid, Lime requirement—3 tons per acre. Available potash, Very High. Available phosphate, Low." This is an instance of a potentially first class soil which is exceptionally acid; oats, which will withstand an appreciable amount of acidity, fail, and only potatoes grow successfully. Where wheat and oats fail through acidity it is useless attempting to grow barley without first applying lime. Recommendation—Apply 3 tons of lime per acre as soon as possible, and 4 cwt. per acre of high grade superphosphates before sowing barley.

Treated on the lines recommended, this field would grow a normal barley crop, and the grass

seeds are likely to take, but without the lime and phosphates both would be a failure.

(3) *The part played by the Advisory Entomologist.*—An unduly large proportion of the corn crops sown on newly-ploughed pasture in 1914–19 were destroyed by wireworm and/or leather-jackets, two voracious pests which are liable to do a large amount of damage to the roots of plants and to cause partial or complete crop failures. They are often to be found in large numbers in land broken from pasture (or ley in case of leather-jackets). During the 1939–45 war a large proportion of this damage could be obviated. There is no known method of killing wire-worms. They may cause damage for 2–3 years in succession. Leather-jackets can be destroyed by broad-casting bran mixed with Paris Green (a very poisonous substance) on a crop which they are attacking, and in any case will disappear at the end of the first year. Recent research has shown that if the number of wire-worms in an acre is less than about 300,000 the pest need not deter a farmer from growing winter corn so long as it is rolled in the spring and top-dressed with a quick acting nitrogenous manure. If, however, the number exceeds about 600,000 in an acre the pest is likely to cause corn to fail and it is better not to plant a corn crop but to sow flax (linseed), peas, beans or mixed pulse which are not seriously damaged by these pests.

If we know the number of wire-worms and/or leather-jackets in a field we are in a position to prevent these pests from doing material damage. This number can be assessed from an examination of a sample of soil, and when the ploughing campaign started the Ministry of Agriculture set up a staff, working under the direction of the Advisory Entomologists, so that any farmer could have this valuable information on request.

(4) *The part played by the Mycologist.*—A somewhat less spectacular part was ably played by Mycologists, none the less disease control did make its contribution. The two most notable instances are to be found in the control of diseases of corn which has been achieved by the introduction of organomercury seed dressings, and the popularizing of potato-spraying.

(C) *The introduction of new stock foods and the efficient utilization of available foods.*—One of the outstanding instances is to be found in the development of the practice of ploughing and re-seeding poor pastures and of the use of temporary leys. This has been achieved under the inspiration of the team engaged in pasture research during recent years. The two practices have resulted in a considerable increase in the productivity of existing pastures in spite of the shortage of mineral manures—an increase which has done much to compensate for the decrease in the pasture area, and has been an essential factor in the maintenance of the milk-supply.

The demand for self-efficiency focussed attention upon silage.* Recent research has provided data regarding the principles underlying the process of ensilage. This has enabled farmers to eliminate many of the failures that were at one time associated with its production. Equipped with the results of modern silage research in a wet season a farmer can make good silage with more certainty than good hay. The composition of different samples of silage differs considerably, but here again the Advisory Chemists have come to the farmers' assistance and provided the data to enable silage to be used to the best advantage.

Another direction in which science has come to the assistance of dairy farmers is in connection with concentrated food stuffs. For twenty years prior to 1939 dairy farmers had at their disposal an adequate supply of imported foods. These greatly decreased under war conditions, and dairy farmers had then to make themselves nearly self-supporting. The fact that they were able to change over to home-grown foods without seriously diminishing the country's milk supply must be credited to the team that worked on the rationing of dairy cows.

Drastic reductions had to be made in the supplies of food available for pigs and poultry; but an even smaller amount of food would have been available for them but for the introduction of concentrated swill. The method of processing this material, that reduces kitchen waste to a form in which it can be transported, was perfected by the combined efforts of chemist and engineer during the war, and by March, 1943, 30,000 tons of kitchen waste a month was being collected and processed.

New Products.

We live in an era in which constant change is the order of the day. New ideas are continuously being evolved, whilst new foods, manures, varieties and remedies frequently come on to the market. Some are superior to those in use, many have no particular merits, and others are worse than useless. To add to farmers' difficulties, many commercial firms employ salesmen who have, or profess, a certain amount of scientific knowledge in addition to a versatile tongue. Some of these are handling useful products and offering them at a reasonable price, and are, at times, helpful to their customers; but there are others who abuse science by using their spurious scientific knowledge to induce farmers to buy extremely expensive and sometimes valueless materials. One of the most difficult problems confronting the modern farmer is to sort out the wheat from the chaff, and in this connection a sound scientific training is invaluable as is the advice of Alexander Pope:—

> "Be not the first by whom the new are tried,
> Nor yet the last to lay the old aside."

Facilities exist for testing new ideas and new products. In most cases it is possible to obtain reliable guidance regarding the merits of new materials. Farmers are wise to refuse to discard old and tried methods for new ones which have not been thoroughly tested. If they have not the information necessary to form an opinion they can obtain help from the Advisory service.

The Advisory Service.

Prior to 1946 the Advisory service consisted of sections: (1) The County Agricultural Organizer and his staff, (2) The Provincial Advisory officers, (3) The Research Institutes, (4) The Ministry's Live Stock officers.

The County Agricultural Organizer almost invariably had his headquarters in the offices of the County Council at the County Hall in the county town. He was responsible for organizing all the Agricultural Educational work of the county and for giving advice to farmers. Generally the Organizer had one or more assistants with a knowledge of general farming, horticulture, poultry-keeping and dairying on his staff.

Knowledge on agricultural questions is now highly specialized; and many farming problems can only be solved by specialists. Consequently specialists were stationed at the Provincial Advisory Centres. England and Wales were divided into thirteen provinces, each consisting of a group of adjoining counties. Each province was served by an Advisory Centre, either a University with a department of agriculture, or an Agricultural College, and at these the specialist Advisory Officers were stationed. For plant pests and diseases there were an Advisory Entomologist and an Advisory Mycologist who advised on troubles caused by insects and by fungi and other micro-organisms respectively. The Advisory Chemist specialized on soils, manures, feeding and feeding stuffs and the Advisory Economist dealt with questions of farm accounts, farm management and agricultural economics in general.

At most Centres there was a Veterinary Investigation Officer who dealt with animal diseases of general interest in the province. Also a Dairy Bacteriologist who carried out bacterial examinations of milk and dairy produce and advised in cases of bacterial troubles in such produce.

A number of Research Institutes was set up and at each of these there was a team of workers constantly engaged on specialized research work. Their work was national in character.

It may be that a problem referred to an Advisory officer does not admit of a speedy solution. If he has the means at his disposal a specific investigation designed to furnish the solution to the problem may be carried out. There are, however, some problems which are entirely beyond the means at his disposal, and which can only be dealt with adequately at a Research Institute.

In 1946 the Advisory Service was organized on a *national* basis. It still includes all the branches of work previously in existence and mentioned above, but all are now under one centralized control. For convenience of administration England and Wales are divided up into *twelve* areas. To-day, the N.A.A.S. (National Agricultural Advisory Service) includes special advisory officers in Animal Husbandry, Farm Buildings and Agricultural Engineering in addition to those already mentioned.

The Ministry of Agriculture also has a scheme for the encouragement of live stock by the provision of high class sires. For the purpose of the administration of this scheme, the country is divided into districts, each in charge of a Live Stock Officer, one of whose duties is to give advice on questions relating to the breeding and grading up of live stock.

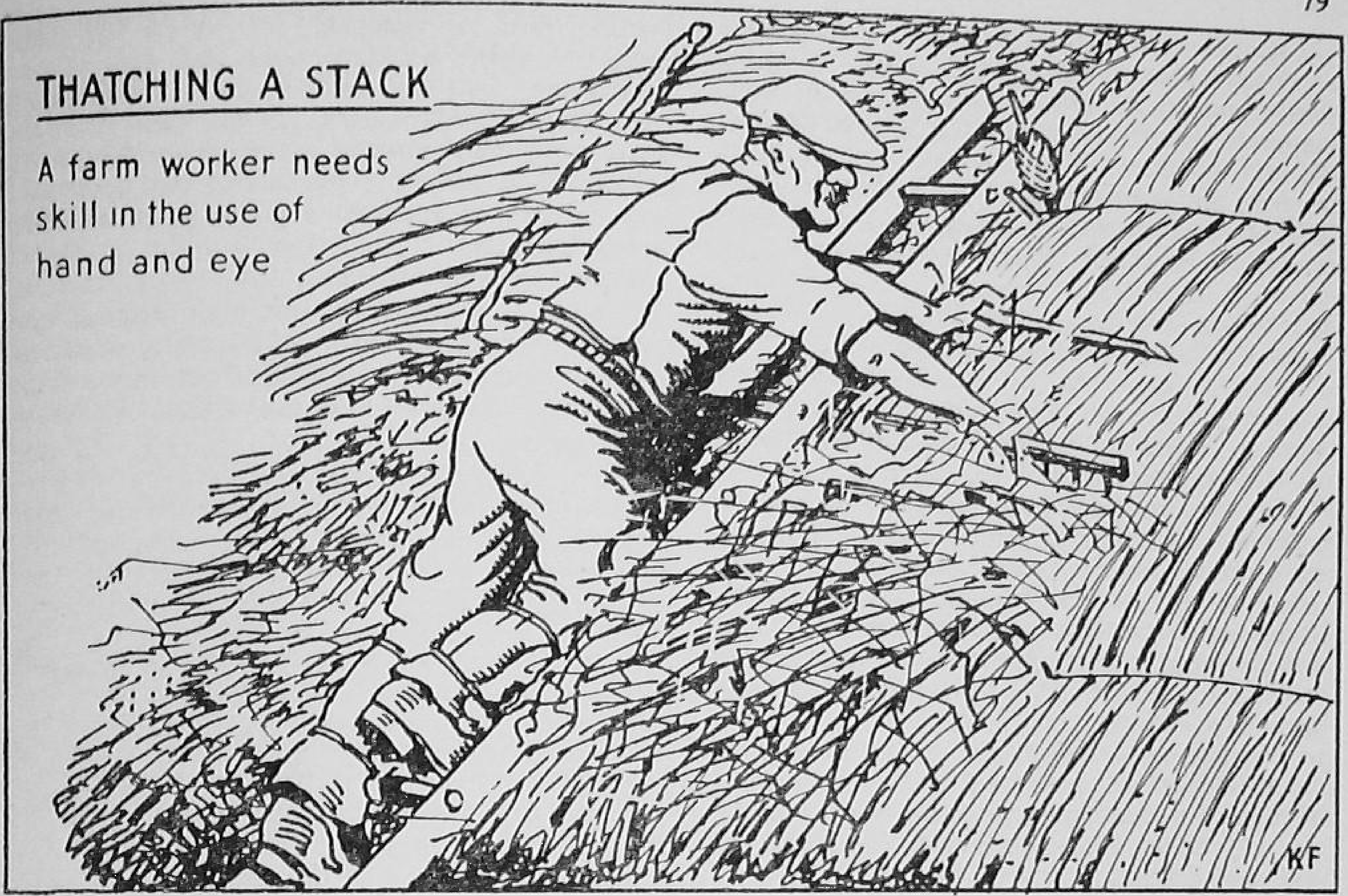


FIG. 25

THE HUMAN FACTORS

In these pages the essential characteristics of the good farmer and the good farm worker are detailed, and their training is discussed:—The Man—Farm-worker and Farmer, their essential characters—Suitability—Training the worker and the farmer—The farmer's wife.

The Man.

THE dominant factor in farming is the " man ". This a fact which stands out very clearly from the mass of data accumulated in a survey of British farming.

A good farm is a valuable asset, but a bad farmer will often be a failure on the best of farms, whilst there are many good farmers who are making a success of very poor farms. Good equipment is desirable, but a bad workman will produce indifferent results with the best implements, and a good workman often gets excellent results with comparatively poor tools.

What, then, are the essential characters of a good farm worker and a good farmer?

At times farm work is most pleasant, but there are other periods when it is very hard and onerous. The worker must have his half-day's holiday every week, and a week's holiday during the year; but the farmer may have to work a seven-day week, and many small farmers work fifty-two weeks in the year. There are days when work must be done out of doors in the most inclement weather; an early start must be made in the morning and oftentimes it is necessary to work late at night for many days in succession, for nature does not observe any working hours, and the hour of the day at which a calf, foal or lamb is to be born cannot be settled even in a democratic country by Act of Parliament.

It is obvious that a farm worker must be tough, physically strong, have grit and energy; he must also have a considerable amount of interest in his work if he is to maintain the spirit which is necessary to force him to give of the best under adverse conditions.

A considerable amount of skill is needed to perform operations such as pruning, grafting, ploughing, land drainage, stack-building, milking and other stock work, and a good farm hand is a highly skilled workman. He needs a good eye, a nimble pair of hands, and a considerable amount of knowledge.

A farmer to be successful must in addition be a good business man, with a capacity to manage labour and be an expert in the cultivation of crops and/or the management of live stock.

How are such men to be produced? There are those who say they are born and not made; but, while it must be admitted that there is an element of truth in that statement, as it stands it is misleading. The fact is that there are some who are and others who are not temperamentally suited for farm work. The latter will not make good farm workers or farmers. Whether or not the former make good farm workers is largely

a question of education and environment.

Observations made in the course of thirty years' experience with young men lead me to suggest that the dominant environmental influence is that of the home. It produces impressions upon the mind of the child which education can modify but can rarely completely erase. In particular, here it is that the tendency to work is, or is not, implanted. Work should not be the sole aim in life, but the capacity to work determines success or failure.

Suffice it here to say that no one should take up farming who is not temperamentally suited for the life or has not the capacity for hard work. Also it may here be pointed out that there is a widely spread idea that a lad who has not the capability for acquiring sufficient skill and knowledge to fit him for other vocations can make good at farming. It cannot be too strongly emphasized that this is a misconception. For the greater part of my life it has needed as keen a brain to make a living from farming as from any other industry.

Turning to the education of the prospective farm worker or farmer, I would commend the precept: " Education develops the mind, but it is only by constant practice that the hand and eye acquire their skill."

The student leaving a Farm Institute is not a skilled agricultural worker, nor is the graduate from an Agricultural College or University Department of Agriculture a qualified farmer. Both need *several years* practical experience before they become qualified.

Training the Farm Worker.

From the farming point of view the education of a farm worker should be designed to develop a good physique, a love of country life, interest in nature and skill in the use of hand and eye. It is true to say that a great deal has been done to give the education received in our rural schools a bias in this direction, but much more can and undoubtedly will be done in the future.

Continuation classes in agricultural subjects and the development of Young Farmers' Clubs is doing a great deal to arouse the interest of the younger generation in farming; whilst there are Farm Institutes where students receive an excellent training in elementary agricultural science and instruction in the more important of the agricultural arts, such as stock husbandry, thatching, hedging, ditching and pruning. Those who desire to become foremen or ultimately small holders should obtain a course at one of these Institutes.

Training the Farmer.

Farming operations are at the mercy of the weather. This makes it impossible to work by rule of thumb or to a stereotyped plan, nor can farming be reduced to an exact science. Methods must be varied from year to year to meet the vicissitudes of our varying climate and the farmer must of necessity rely upon his own judgment when deciding how and when farm operations shall be carried out. A man can only exercise judgment if he has experience to guide him. An opinion which is not based on experience is merely a guess, and in connection with farming operations a guess is more often wrong than right.

Therefore a considerable amount of practical experience is essential to success in farming. A man who takes over a farm without first acquiring a reasonable amount of experience is courting failure, and it takes a long time to gain sufficient experience.

The problem which faces a novice is how to gain sufficient experience as quickly as possible, and he can save a lot of time by learning from others Essential data have been collected in a convenient form in the courses at our Agricultural Colleges and in the text books. From them a student can gain, in two or three years, knowledge which would take many years to acquire by practical experience. He must, however, always remember that having acquired knowledge from a course of instruction or from books, he must also learn how that knowledge is applied in practice. This he can only do by studying *for several years* the working of a farm or farms, under the guidance of a good farmer.

This brings us to the all-important question—What does the student who proposes to take up farming want to learn? Some of the subjects he should study are quite obvious, but there are others which are useful although the fact is less apparent.

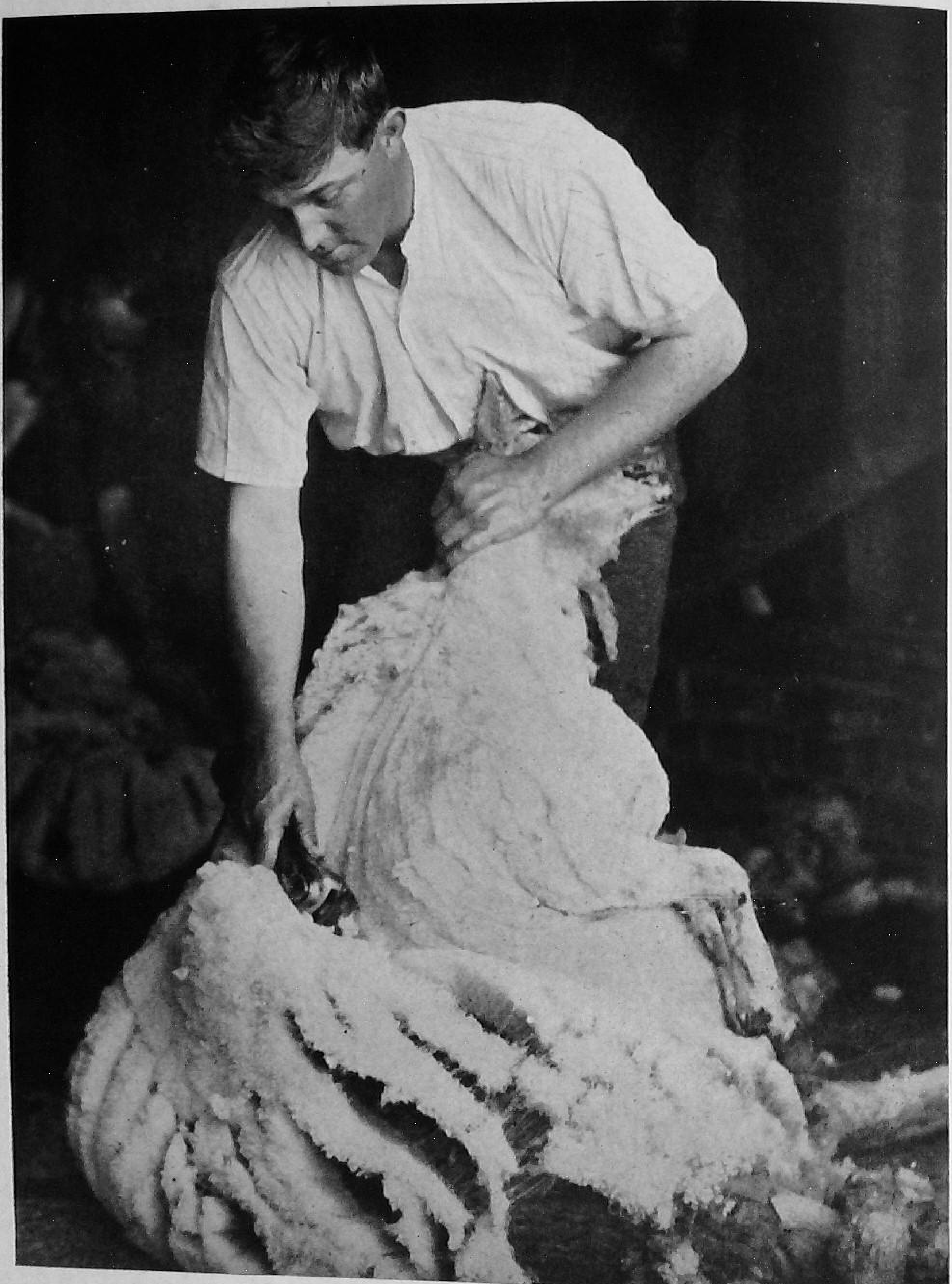
Everything the farmer produces comes directly or indirectly from the soil, so the more he knows about that complex substance the more intelligently he can work, and therefore first and foremost comes the study of soil science. The need for knowledge regarding: (1) the cultivation of crops, including grassland, (2) fertilizers and manures, their composition and uses, (3) the feeding and management of live stock, (4) dairying, (5) the diseases of animals (i.e. Veterinary science), (6) the diseases of plants (i.e. Mycology), (7) insect pests (i.e. Entomology), (8) farm machinery (i.e. Agricultural engineering), is obvious. A pre-requisite to the study of these subjects is some knowledge of the underlying sciences of which chemistry, physics, botany, geology, and zoology are the most useful to the prospective farmer.

The reader will have already appreciated the value of economics and farm accountancy. In addition, surveying, agricultural law and forestry are subsidiary subjects that are frequently useful.

But it does not end there, the training of a *good* farmer goes on as long as he lives; and here it may not be out of place to utter a warning. Country life is comparatively peaceful and it is very easy for a countryman to lose that restless spirit which is the motive power of human

Above: MODERN FARMING: HEADQUARTERS OF A BIG FARM
Photo: Farmer & Stock-breeder. Courtesy: Nackington Farms, Canterbury.

Below: GOOD FARM BUILDINGS: A VALUABLE ASSET TO-DAY
Photo: Farmer & Stock-breeder.



SHEARING A KERRY HILL EWE

Farmer & Stock-breeder Photograph.

progress, and to get into a rut. That is fatal to continued success. A farmer, if he is to be continuously successful, must keep himself up to date and preserve the capacity for adapting himself to the needs of a constantly changing world—he should continue to learn as long as he continues to farm.

The Farmer's Wife.

The " Missus," as she is almost invariably termed, rarely receives her fair share of the credit for the success of a farm. Yet many successful farmers will tell you candidly that they owe much to their wives. Rarely does a farmer make a real success of his farm if he has an " urban-minded " wife. Farmers, like everyone else, can normally take a reasonable amount of recreation, but they often cannot do so as and when they choose. For nature is the task master which the farmer must serve, and there are times when for several weeks he should be tied to his farm, or when for many nights in succession he must maintain a vigil. Again, sooner or later every farm has its bad years, and then the bank balance is low—sometimes the overdraft is unduly high. These are the testing times, for then, if the farm is to be a success, it must come first, even if everything else has to be sacrificed.

At such times the farmer's wife, whose heart is in the farm, can by sharing the burden cheerfully, do much to ease its weight, whilst an " urban-minded " wife with no interest in the farm may well be a millstone too heavy to carry.

This is a point which every young man who is thinking of taking up farming as a career should consider seriously. If he has an " urban-minded " wife or is thinking of marrying one he would be wiser to leave farming alone and take up some other calling.

LOOKING AHEAD

In a final section brief reference is made to the factors which will dominate the future and to the probable effects upon the various branches of farming; The Basis, the Nation's needs—The future: arable farming, cattle, sheep, pigs, poultry, horticulture—The road to success in farming—A last thought.

A SURVEY of British farming would be incomplete without some reference to the future. It would be rash to give a definite forecast but there are pointers which carry a clearly marked indication of what lies ahead in certain directions.

The Basis.

The first question which arises is—what will be the best system of farming; should the land which has been ploughed from grass during the war go back to pasture in the future? In this connection there are pointers.

Farming policy must be governed by the fact that the country has been impoverished to an unprecedented extent by the war. Between 1938 and 1941 a large proportion of our foreign securities were cashed to provide the money to purchase necessities from abroad, and in the period 1941–3 much of our Asiatic property was destroyed or rendered valueless. As a consequence the standard of living of the people of this country can only be maintained by increasing the productive capacity of these Islands.

For this reason it is desirable that British farms should produce their maximum economic output.

If the productive capacity of the farms is to remain at a very high level the system or systems of farming practised must be such as will ensure that the fertility of the soil be maintained.

Also under war conditions the need for economy in the use of shipping made quantity the main consideration in our food production. It was necessary to increase the production of corn even though this meant reducing the size of herds and flocks. When the war ended, it became desirable to rebuild herds and flocks as quickly as possible. This, because owing to the depletion of our foreign balances the value of farm produce must be in times of peace more important than the quantity of food, and animal products have a higher value than corn—a fact that can be seen from the figures for the estimated value of the agricultural output for England and Wales for 1937–38.

ESTIMATED VALUE OF AGRICULTURAL OUTPUT FOR 1937–38.*

Milk and dairy produce	£59,280,000	£59,280,000
Other animal products.		
Cattle and calves ..	30,520,000	
Sheep and lambs ..	15,930,000	
Pigs	£25,430,000	
Poultry	5,860,000	
Eggs	16,740,000	
Wool	1,710,000	£96,190,000
Corn.		
Wheat	6,410,000	
Barley	4,410,000	
Oats	1,580,000	
Other corn	510,000	12,910,000
Potatoes	11,940,000	11,940,000
Sugar beet	4,660,000	4.660,000
Hops	1,980,000	1,980,000
Sundry Crops.		
Hay	2,840,000	
Straw	820,000	
Mustard seed ..	180,000	3,840,000
Market Garden Produce.		
Fruit	7,250,000	
Vegetables	17,770,000	25,020,000
Glasshouse Produce, flowers and nursery stock	8,770,000	8,770,000
		£224,590,000

* From Agricultural Statistics, 1938 (Min. of Agric.)

General Line of Farming Policy.

Thus the first pointer indicates, that, after war, we need still, of course, to produce the economic maximum from the land, maintain soil fertility and at the same time rebuild the country's herds and flocks. These aims can best be attained by:

(1) Keeping as much land as possible under the plough, because an acre under arable cultivation will produce about twice as much as it will if under permanent pasture.

In this connection it may be pointed out that the extent to which it is possible to keep land under the plough is determined by the price level. The cost of cultivating arable land is comparatively high, whereas the cost of managing permanent pasture is low. As a consequence, if prices fall the poorer land has to be put down to permanent pasture. This is shown by figure 26 which indicates what must happen as the price of wheat falls in the case of land upon which wheat is the principal crop with wages at their present level.

(2) The more general adoption of the system of alternate husbandry (the ley system). This system enables the maximum amount of stock to be kept in conjunction with arable farming and is the cheapest and simplest method of maintaining soil fertility on arable land.

(3) Improving, where possible, the permanent pastures which remain. These consist of two classes (*a*) very good pastures, (*b*) poor pastures which are not suitable for arable cultivation. The latter are almost invariably improvable. In many cases their productivity can be more than doubled by ploughing and re-seeding.

Live Stock.

The second question which arises is:—If herds and flocks are to be rebuilt, what type of stock will be required? Here there are several pointers.

A steady increase is discernible in the demand for whole milk, and there is every reason to anticipate the demand will continue to grow. Thus a *slow* but steady increase in the number of dairy cattle is to be anticipated.

There is a very great potential market for home-fed beef. With wages at their present level, stall feeding of fattening cattle during the winter is not a very attractive proposition, and is a practice which is not likely to increase. But if ley farming is extended and existing poor permanent pastures improved, a very much larger number of cattle would be required for fattening on the grass during the summer and early autumn. This would appear to offer the main avenue for increased beef-production.

I am bold enough to predict that typical beef breeds of cattle will always find a place in British farming, but there can be no denying the fact that on reasonably good land the cost of producing and rearing a calf from a cow which only produces the milk for one calf a year is liable to be unduly high. On reasonably good land this item can be reduced to a very low figure by using cows which will produce enough milk to rear seven or eight calves a year. Therefore, for beef production in conjunction with ley farming, dual purpose cattle are worthy of serious consideration.

The position of sheep is somewhat similar to that of cattle. Folding sheep on roots during the autumn and winter has long been a fundamental part of the system of farming on many light land farms, but under existing conditions it is an expensive practice, and for that reason is not likely to expand. On the other hand, production-costs are usually comparatively low in the case of grass sheep, and this system of management, particularly on leys, affords the main hope of increasing the sheep output.

Another point worthy of attention is the question of prolificacy, which is a very important factor in determining the cost of lambs. There are flocks which rear 150 per cent of good lambs, and others where the lamb average is not more than 110 per cent. The prolific types are worthy of very serious consideration when the time comes for increasing the sheep population.

Pigs and poultry, which before the war were fed mainly on imported foods, had to be drastically reduced when the shipping problem became acute. But, if the food is obtainable, the 1937–38 receipts from both of these classes of stock could be very considerably increased without encroaching appreciably on other farming activities. Food costs are only 50–60 per cent of the cost of the finished product, so that a considerable saving in foreign exchange can be effected by purchasing food and producing these commodities in this country. Thus these branches of farming should be rebuilt fully as soon as it is economically possible.

Personally, I find it difficult to work up much enthusiasm over specialized pig or poultry farms.

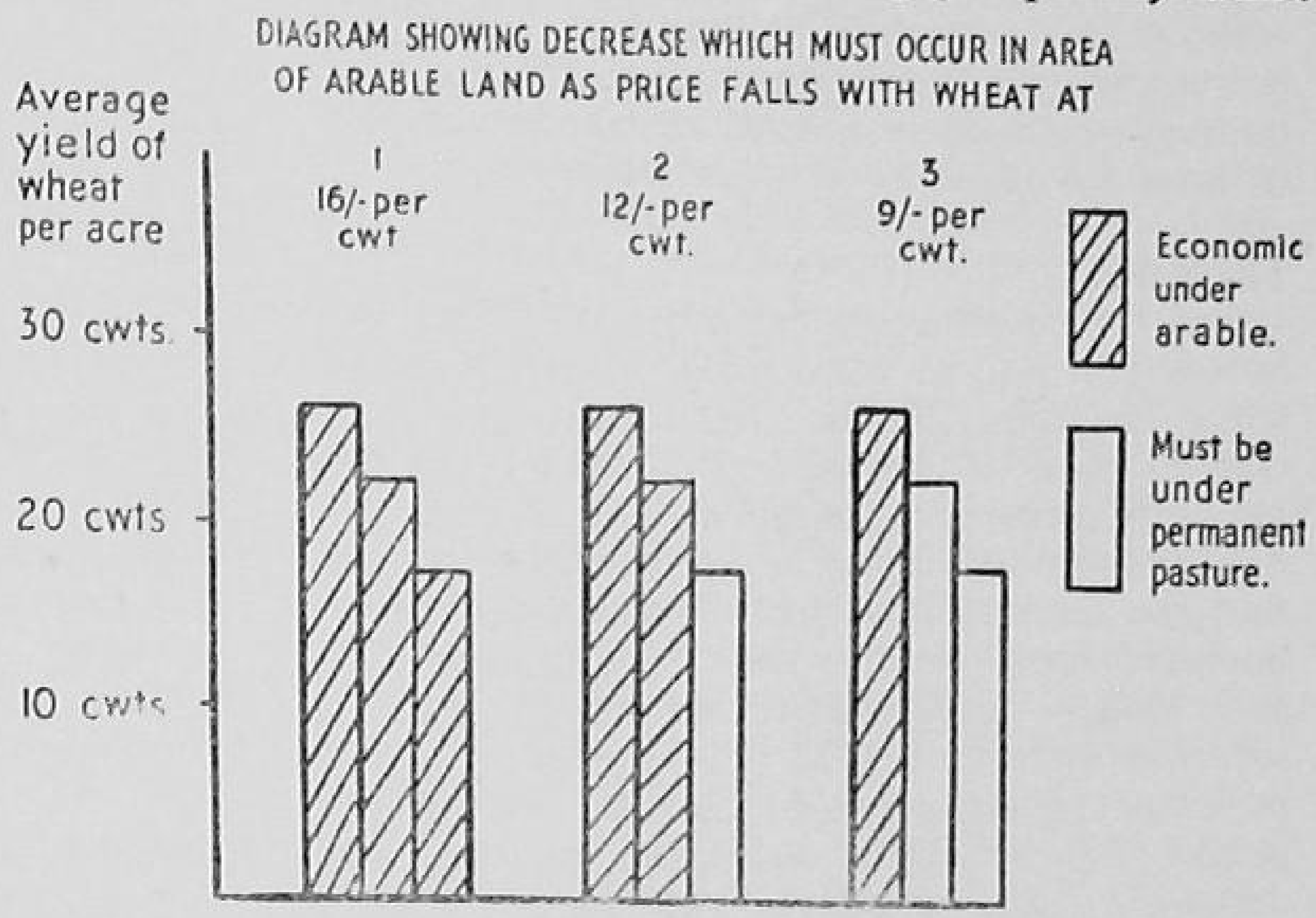


FIG. 26

Many have been successful in the past, but also a large number have failed. The fact is that disease and price fluctuations make them a gamble. But pigs and poultry can be run conveniently in association with other branches of farming. It is a comparatively simple matter to keep farm units free from disease, and many managerial problems which present considerable difficulty on a specialist farm, fade into insignificance on a general farm. There are few, if any, farms upon which an economic unit of both could not find a place with advantage, and that is where these branches of the industry can be best developed.

Market gardening crops, fruit and other horticultural products have extended their scope since the outbreak of war. Large quantities of such material used to be imported when it could be produced with advantage in this country, and the market for this type of product should grow slowly but steadily. It is a valuable market and one which offers scope for enterprising men. But horticultural produce is perishable and the market is easily glutted. Thus, although there is a possibility of development in this direction, it should be carefully controlled, for indiscriminate expansion could do harm to the whole of what is a very valuable branch of agriculture.

The Road to Success.

From time to time enthusiasts arise who

advocate the merits of some system so eloquently that it may appear that in it lies the salvation of British farming. Some such schools of thought which are active at the present day appear worthy of consideration.

What is termed " farming on factory lines," is one of the systems which has been advocated. To many it means remodelling the countryside, stubbing up hedges, filling ditches, amalgamating adjoining fields and farms to form large areas upon which the largest modern machines, and large units of pedigree stock could be operated under a staff of " experts." Others urge the merits of small holdings with comparable enthusiasm. The merits of mechanization are constantly being widely advocated by its supporters, and there is always a large body of people who look to science to provide the solution of all farming troubles. Such things certainly have their uses.

But both large and small holdings find a place in modern farming. Machines are largely used by modern farmers, but there is a limit to their scope—mass production methods produce results with crops and stock which compare unfavourably with those obtained from the individual care and attention of skilled husbandmen. Science will open up the road to progress, but as a rule it leads the way forward slowly.

Useful as such things undoubtedly are they do not provide the key to success in farming. That can only be achieved by the diligent application of the principles of what in this book is termed " Good Farming."

A Last Thought.

To many readers much that has been written in the foregoing sections may come as a rude shock, for to them the glory of the British countryside has been its genial, kindly country folk and its peace. Must these be sacrificed on the altar of progress? Must the genial country folk give place to jostling business men, and the peace of the countryside be broken by the throb and roar of internal combustion engines.

Fortunately that is not likely to be the result of progress.

The worst threat to its peace comes from holiday makers who at times invade the countryside in an endless stream of noisy cars, but even that only touches the fringe. Education certainly does not cause a deterioration in the character of countrymen, why should it? And the noise of internal combustion engines is muffled by distance. Normally they sound little louder than the drone of an insect. I write only five miles from one of the busiest coast roads—but a mile away on the top of a hill it is possible to look over one hundred square miles of the adjoining countryside, which is normally as peaceful as anyone could wish. Any night you can stand there at sunset without hearing a sound other than the song of the birds, the drone of insects, or the lowing of cattle, and in truth can echo the words of Gray:—

> " The curfew tolls the knell of parting day,
> The lowing herd winds slowly o'er the lea,
> The ploughman homeward plods his weary way,
> And leaves the world to darkness and to me."

GOOD FARMING

Useful Glossary of some terms used.

ARTIFICIALS — ARTIFICIAL FERTILIZERS — ARTIFICIAL MANURES.—Three terms which have the same meaning. F.Y.M. and the excreta of sheep, poultry and humans are regarded as "natural manures," and all the purchased manures as artificials. There are simple or straight artificials, i.e. manures which supply either nitrogen, phosphate, or potash, and mixed or compound manures which supply two or three of these constituents—the term "complete manure" is often used for mixtures which contain all three constituents. There are some manures (such as shoddy, castor meal, fish meal, blood meal) which are residues from plants or animals; such manures are often referred to as organic manures.

BALANCED RATION.—A ration in which the nutrient ingredients are in the correct proportion for some specific type of stock. For example, ·6 lb. protein equivalent and 2·50 lb. of starch equivalent are required to produce 1 gallon of milk. A mixture of concentrates of which 2·50 lb., 3 lb., or 3·50 lb. contains ·6 lb. of protein equivalent and has a starch equivalent of 2·50 lbs. would be called a balanced milk ration.

BRAES.—Rough grazings.

BRAIRD.—A term used for young crops just as they are coming through the soil.

BULLING HEIFERS.—Maiden heifers which are big enough to be stocked.

CHAT POTATOES.—When potatoes are sorted they are usually divided by size into three portions. The large tubers, which are saleable for human consumption, are known as ware; the medium-sized tubers or seed potatoes can be sown, and the very small potatoes, or chats, are used as stock food.

COCKS.—When a crop, which has been cut loose, is to be dried in the field it is often formed into small, more or less conical, heaps—these heaps are known as cocks and the process of forming them as "cocking."

CONTROLLED GRAZING.—Regulating the stock to the capacity of the pasture. This may be done by increasing or reducing the number of stock according to the amount of grass and the rate of growth, or by alternately grazing and resting the pasture,

COVER CROP.—Grasses and clovers which grow slowly are usually sown in conjunction with a rapidly growing crop such as corn, rape, or Italian ryegrass. The rapidly growing crop affords the grasses or clovers protection in the early stages of their growth and is therefore known as a cover crop.

CULLS.—Animals which are to be discarded. The process of going through a herd or flock and picking out culls is known as culling.

FALLOW.—Land which is bare. A "bare fallow" is the practice of leaving land uncropped for a whole year. A "half," or "bastard fallow," is the practice of leaving land uncropped for part of the year. A fallow crop is an arable crop grown in rows two feet or more apart.

FLYING FLOCK.—In some cases a flock of ewes is purchased in the spring. They are lambed and fattened for sale as soon as their lambs have been weaned. This is what is known as a flying flock.

FOGGAGE.—Aftermath or latermath. The grass which grows after a crop of hay has been cut and carted.

FOLD.—A moveable pen usually made with hurdles or wire. A fold is usually erected on a growing crop to enable sheep, or pigs, to consume the produce where it is grown—each day the fold is moved on to fresh ground or enlarged. The process of consuming a crop by sheep, or pigs, which are "folded" upon it is usually known as folding.

FREEHOLD LAND.—Land, the owner of which is free of all service except to the Crown. Fixed charges have long since been substituted for service, so freehold land is free from serious fixed charges. There are, however, certain exceptions of which tithe and statutory charges such as a drainage rate are the most important. Before purchasing a freehold property it is necessary to ascertain if it is subject to such charges.

FURROW (In the furrow).—When land is ploughed the plough cuts up and turns over a strip which stretches more or less continuously from one end of the field to the other; this is known as the furrow slice, but is often referred to as a furrow—strictly speaking, however, the furrow is the space left by the removal of a furrow slice. When land has been ploughed and the furrow slices can still be seen the soil is said to be lying "in the furrow" which, of course, should be "in the furrows."

HAY-MAKING.—The process of drying grass and turning it into hay.

HUMUS.—Farmers usually use this term to describe the whole of the organic materials in the soil. Chemists use it in a more restricted sense—to describe the brownish or black substance formed by the decay of organic materials.

KEEP.—A colloquial term for food which is generally used in connection with grass or forage crops. The amount of keep in a pasture means the amount of edible grass.

LAID CORN.—Growing corn should stand upright, but at times the straw is not strong enough to hold the grain in a vertical position and it bends over assuming a more or less horizontal position; where this happens the crop is said to be "laid." A heavy wind or rain will often beat a crop down, i.e. lay it.

LAID DOWN TO GRASS.—Means "formed into a pasture."

LEGUMINOUS CROPS—PULSE CROPS.—A family of crops which have flowers somewhat similar to those of the pea, and which form pods to carry the seed. There are nodules upon their roots within which are to be found bacteria which form nitrogenous compounds from the nitrogen of the air.

MANURIAL RESIDUES.—The whole of the manurial ingredients applied to the soil are not as a rule used up by the crop to which they are applied. Some part of them is left in the soil for future crops. Also most crops leave in the soil residues which will be useful to crops which follow. All such residues are termed manurial residues.

MECHANICAL CONDITION OF THE SOIL.—Is another name for the physical condition of the soil. It is usual to judge the mechanical condition of the soil by the way it works when tilled. If a soil breaks down readily when tilled its mechanical condition is good, upon the other hand, if a soil will not break down readily when tilled its mechanical condition is said to be bad.

NET ANNUAL VALUE.—The rent which a property can reasonably expect to earn from a good tenant if let in the open market is known as the gross annual value. But a certain amount must be expended on repairs, and any fixed charges must be paid, these sums are deducted from the gross annual value and the residue is known as the net annual value.

Example Gross rent £500, modern buildings costing £50 per annum to keep in repair, tithe £100 per annum. The net annual value £350.

NICK IN.—A term used in connection with the mating of stock to indicate the fact that the characters of two animals "blend" well if mated.

NATIONAL MARK.—A mark which may be affixed to produce which conforms to a standard laid down by the Ministry of Agriculture.

PERMANENT PASTURE.—Grassland which is never ploughed.

PRAIRIE.—Land carrying the herbage that grows naturally.

PRE-POTENT SIRE.—A male animal in which the power to transmit its own characteristics to its offspring is well developed.

PROTEINS—CRUDE PROTEIN—TRUE PROTEIN—EQUIVALENT. Proteins are complex organic bodies characterized by the fact that they contain about 16 per cent of nitrogen, and small quantities of sulphur and phosphorus in addition to carbon, oxygen and hydrogen. All the fleshy substances of animals are proteins, and an animal can only form such materials from proteins. Plants build up proteins, but they also form certain other nitrogenous materials which contain 16 per cent of nitrogen. When a chemist analyzes plants he ascertains the amount of nitrogen they contain and multiplies this by 6·5 the result being known as the crude protein—this consists of the sum of the true proteins and the non-protein nitrogenous material. The protein equivalent is the percentage of true protein, plus one-half the percentage of non-protein nitrogenous material.

PULSE CROPS.—See leguminous crops.

RESIDUAL VALUE.—The value of manurial residues.

ROTATION—NORFOLK FOUR-COURSE ROTATION.—A rotation is a sequence of cropping. In the Norfolk four-course the sequence is roots, spring corn, seeds (one year), wheat.

SCOUR.—The agricultural term for diarrhœa.

SILAGE.—The food stuff which results from ensiling a green forage crop, ensiling being the name given to the process of preserving green forage in a succulent condition as opposed to making it into hay.

STARCH EQUIVALENT OF A FOOD.—May be defined as: "The amount of starch which if fed to an animal would produce the same effect as a given quantity of the food in question.

STOOK.—When corn has been cut and tied, the bundles which are formed are known as sheaves—in a sheaf all the ears are at one end, the reverse end being known as the butt. Now, if the ears of corn lie on the ground and it rains the corn will grow; in order to obviate this the sheaves are set up on their butts in pairs with their ears locked together—and to prevent them falling over three, four, or five pairs are put together, forming what is known as a stook. The operation of forming stooks is known as stooking, and when all the corn in a field has been set up the field is said to be stooked. A shock is another name for a stook.

STORES.—Animals which are not fat.

SUPPLEMENTARY RATION.—A considerable part of the ration of many farm animals consists of bulky foods such as hay, straw and roots. An animal cannot eat sufficient of such foods to enable it to grow at the maximum rate or produce the maximum amount of milk. Therefore bulky foods must be supplemented by more highly concentrated foods. The concentrated foods required are therefore termed the supplementary ration.

SWATH.—When a crop is cut with a mowing machine with a horizontal cutting bar (or with a scythe) the cut material lies in rows, flat upon the ground. These rows are called swaths.

TILTH.—When cultivating soil to form a seed bed, eventually a stage is reached in which the uppermost layer consists of comparatively small clods mixed with fine mould. This condition is known as a tilth. If the clods are comparatively large and form the bulk of the broken material the condition is known as a coarse tilth; on the other hand, if the clods are small and the bulk of the loose material consists of fine mould the condition is known as a fine tilth.

THREE LAMB EWES.—Ewes which have produced lambs in three consecutive years.

TAIL CORN.—The small or very light grains.

TOP DRESSING.—The practice of applying manure to a growing crop.

WADS.—Another name for cocks.

WEATHERING.—The disintegration of materials on the surface of the earth due to exposure to the natural agents such as wind, rain, alternate wetting and drying, alternate heating and cooling, and frost.

WHITE STRAW CROPS.—This term is applied to wheat, barley, oats and rye.

WORKING CAPITAL.—Is the money necessary to run a farm, i.e. to buy stock, pay wages, purchase manures, feeding stuffs and defray other out-goings.

YEARS' PURCHASE.—A term used by valuers. In estimating the capital value of a property it is usual to multiply the net annual value by a factor which varies according to the nature of the property, this factor is usually referred to as the number of "years' purchase." In the case of a farm equipped with reasonable buildings the years' purchase used is generally 25.

SECTION II

GOOD FARM WORKMANSHIP

by

D. V. FLETCHER

Illustrations by

XAVIER WILLIS

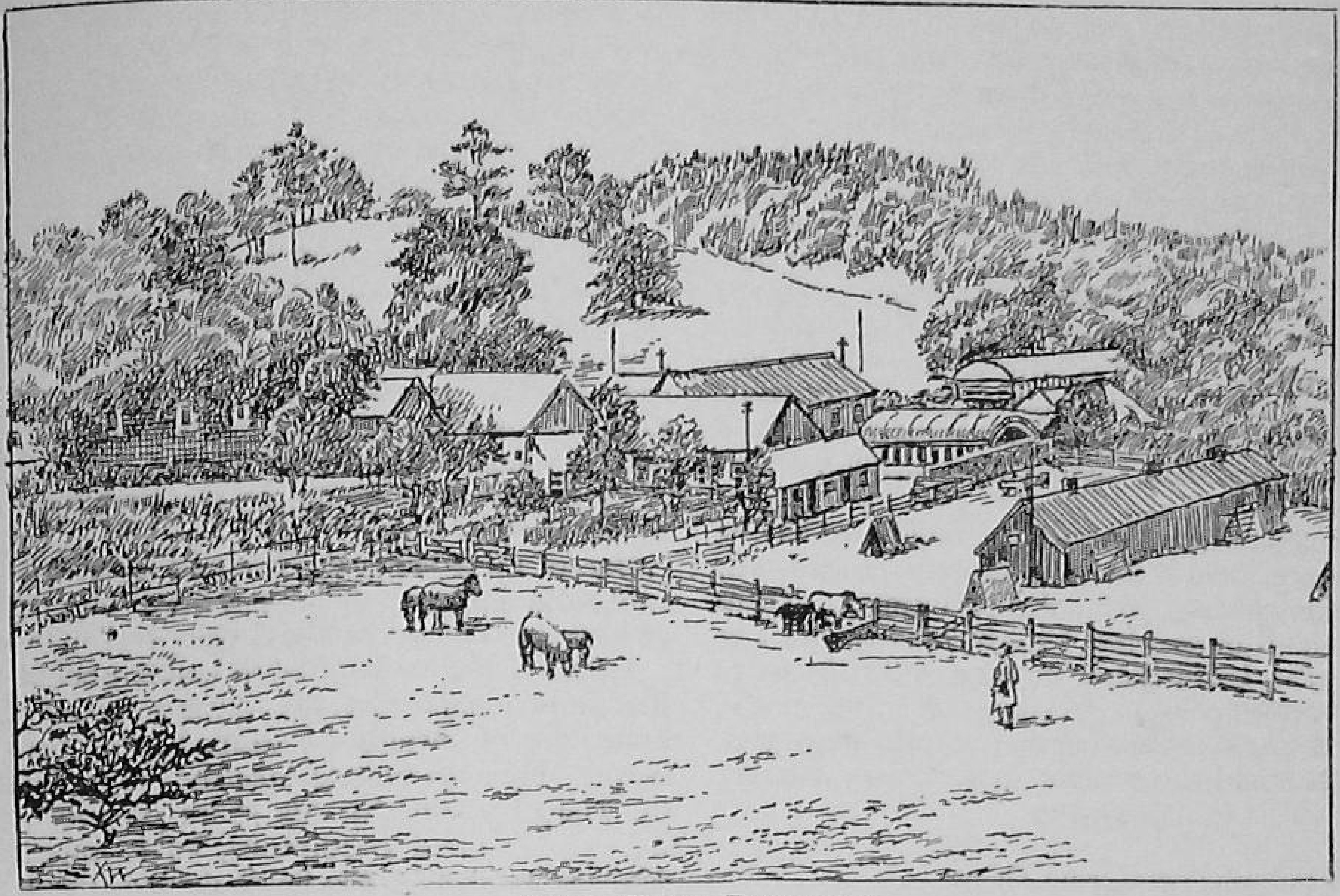
INTRODUCTORY NOTE

In agriculture, the manual work of the farm, on the one hand, and tasks which are classified as managerial, on the other, are very closely interwoven. I find it hard to separate the two, and in consequence certain descriptions of jobs explained in this section contain references to the business side of farming as well as to workmanship.

The length of the working week, the wage paid, holidays and so on differ somewhat in different counties and are laid down by the Agricultural Wages Board.

The work described in this section is such as is generally encountered on the ordinary mixed farm. No mention is made of the less common jobs such as cheese-making, bacon-curing and the like.

I should like to express my appreciation and thanks to the *Farmer and Stockbroker* for their kind loan of the photographs from which Mr. Xavier Willis made his illustrations.



GOOD FARM BUILDINGS

GOOD CRAFTSMANSHIP ON THE FARM

We are introduced to the subject. The author exhibits his credentials. Even an experienced farmer makes mistakes. The charm of things that live appeals to the author, this sentiment is essential to success as farmer; your heart must be in your work. The townsman keen on pets and gardens could live happily on the land. The author has a soft spot in his heart for the gypsy because he takes such good care of his animals. The author likens agriculture to nursing the human child; the feeding of the plant is bound up with the art of agriculture.

Skilled Work.

WHETHER the townsman has been in the country on a visit or has merely passed through it by road or rail, he will surely have noticed the symmetrically shaped stacks, the beautifully ploughed fields and the neat wickerwork appearance of the freshly laid hedge. In fact these three features being the most conspicuous evidences of order and skill on a farm seem, to the layman, to cover good agricultural craftsmanship. In actual practice, these things merely touch the fringe of the skilled work on the land and in this book the reader will be introduced to the other craftsmen whose work is not so apparent to the uninitiated. Perhaps, after he has read this volume he will look upon the countryside with different eyes. I hope so.

Qualifications for Writing.

First of all, I had better let you have my own qualifications for writing about work on the land in this country. I happen to have been born on a farm and, excluding schooldays and soldiering days, have spent a large part of fifty years on the land. I started farming in Yorkshire (my native county), twenty-one years ago, but moved to Kent about ten years since, where I still farm for my livelihood. It must be admitted, however, that in spite of all these years of experience, I still find myself making very stupid mistakes at my job. Whenever I think of these mistakes afterwards, I generally have to acknowledge that I not only *ought* to have known better but *do* know better. But there it is.

Now, this is the point up to which I am leading: a book on any aspect of farming may be invaluable, but do not run away with the idea that you can learn how to do a job on a farm or how to manage a farm by reading about it alone. It just cannot be done. And, however intelligent you may be, you will still have a great deal to learn about farming even if you live to be a hundred.

Living Things.

To my mind, the greatest charm of farming lies in the fact that it is constantly concerned with living things: all the animals, all the crops, all the weeds—even the soil itself is teeming with multitudes of microscopic life. I personally do not think that you will ever achieve that happiness in your work on the land which is surely what everyone wants, if you have not got that feeling for living things, be they animals or plants. My tip to those thinking of going on the land either

as farm workers or farmers is this: Do not pretend to yourself that you have a liking for and an interest in living things; you either really *have* it or you *have not;* you yourself will be the only one to know this. And however much you may deceive either yourself or other people, you cannot deceive nature. If you do not feel like this about the land (plenty of people do not), choose another means of livelihood. Farming can be a dreadfully monotonous job if your heart is not in it. You will have to live with it, you will have to go to bed with it, you cannot really get away from it. Nothing is more delightful if you are fond of it, nothing more irksome if you are not.

At this point I must plead guilty to having expressed myself forcibly, on many occasions, concerning the drawbacks of farming. There have been times when I might have said, "I'm sick of it, I wish I'd never gone in for the job." But that happens when everything, including the weather, has gone wrong for a week or two. I do not really mean it and I should not care to have any other occupation.

The Craftsman and Living Things.

What has this question of the liking for living things got to do with good craftsmanship? This much: a number of characters are depicted in this book; all are *specialists* at their jobs. I hope that you will notice the same characteristic in each of them: the love of living things. They would never have become good craftsmen unless they had had that.

I want to enlarge on this topic before we get down to the actual work on a farm.

Perhaps the dear old lady who lives at the end of your street keeps cats. All the neighbours laugh about this and in extreme cases, suggest making complaints to the Ministry of Health about the insanitary condition of her house. If she is fanatical about cats, such complaints are probably justified, but *I can see her point of view.* Instead of being an object for ridicule, I believe that she is to be envied in her possession of this feeling for animals. At any rate she is getting *something* out of life. I do not think that everyone can honestly say that, nor do I refer to people in any particular class of society. After all, what a large number of townspeople are keen on canaries, pigeons, dogs, goldfish, window boxes, tame mice, gardens and so on! In my opinion, such people could live a very happy life on the land.

The Gypsies.

There is a race of people with whom the farmer is constantly coming into contact, the gypsies. Here are some instances of their close sympathy with animals. They say that every man's hand is turned against the gypsy. Perhaps so, but he is generally a wonderful horseman and a first-class dog man. You will not often see gypsies' horses or dogs that are not well cared for by their owners. For my part, I am quite prepared to overlook many shortcomings in a man who takes good care of an animal.

Some years ago, I employed fifty or sixty gypsies for about a month to pick peas. They arrived in ten caravans complete with horses and, of course, with the usual greyhounds. The encampment was in one of our fields; the horses were kept in another. In spite of free fights, rows and quarrels between the different families, none of them ever laid so much as a finger on any of the horses or dogs during the time they were on the farm.

One of these same gypsies had a pet cat—the only time, incidentally, that I have ever known such people to have a feline pet—this man wore a poacher's coat with a large inside pocket and, wherever he went, puss was always carried about in this pocket, where she seemed to be perfectly happy. He even used to take the cat to the local inn when he went for his share of good cheer (a fairly frequent occurrence, as it happened). When he worked in the fields during the day, he took off the famous coat, fished puss out of the pocket and laid her on the coat in the sunshine. She used to sleep there all day and kept strict guard over her master's property until work stopped.

Perhaps I stress this point about living things too much. I do not know. But what a difference it makes to one's daily work and life if one is really interested in the job. You will never become a good craftsman in any industry if you are not interested in it.

A Favourite Simile.

There is a favourite simile of mine regarding farming. I imagine the soil to be like a cradle and the crops growing in it to be like babies. We all know that babies require water and a variety of nourishing foods, that they should have careful nursing when they are very young and that the attention devoted to them should be given at the appropriate times. Well, plants are just the same. One can quite appropriately regard agriculture as a form of nursing.

Moreover, do not make the mistake which so many people, including some farmers themselves, make, of imagining that the soil has been specially endowed with an inexhaustible supply of food for plants. It has not. Every farmer has to put that food into his land; the kind of plant food, the quantity and how it is to be supplied, are of course bound up with the art of farming.

Does this sound easy? I am afraid it is not. However, let us get on to the next chapter and make the acquaintance of some of the men who do the job.

THE COWMAN

We meet Jack Sharp the head cowman; he is 33 now and he has been working with a dairy herd ever since he was a lad. To-day he is in charge of a commercial herd. Some general points about milk production are explained. Jack is provided by his employer, Mr. Bishop —known to all on the farm as " the governor " —with the cows, the food and the tools; this section shews us how he does the work. We begin with winter duties and the cows' first meal of the day. Concentrated foods are rationed for each cow according to her daily milk yield. We meet Harry Taylor, the second cowman, and another hand on the farm, David Edge. Harry now helps with feeding; David's work is to see that udders, tails and right flanks of the cows to be milked are thoroughly cleansed with cold water. After certain other preliminaries milking begins—a milking machine being in use. Cooling is explained and we are instructed in the art of dealing with a difficult cow. A case of illness is investigated. Some routine jobs are carried out, including mating. Cleaning out the cowhouse and washing milking equipment occupy some time; Clarence, the bull, must be exercised. Then comes dinner. The afternoon work is described: it includes milking again. Some differences of procedure from winter practices are found during summer months, these are dealt with. A number of troubles may beset the cowman's charges, of these some account is given. Calving is explained.

Jack Sharp.

JACK SHARP is head cowman in charge of a dairy herd of fifty cows. He is a specialist and knows his job from A to Z. What is his job and what are his duties, did you ask? Here we are.

Jack's employer is a first class farmer. One would expect that, because Jack is most certainly not the type of man to stay on a farm which is not properly managed. Good masters and good men generally go together. By the way, one important hint to those who are thinking of taking a job on the land. Whenever possible, try to get a job with a first class farmer. In the first place you can learn from him how a job is done properly, and in the second place, when you have gained sufficient skill to enable you to apply for one of the higher paid and more responsible jobs in farming, your application is 75 per cent successful from the start if you can say that you have worked for Mr. So-and-So for several years, assuming, of course, that Mr. So-and-So is a well-known and successful farmer.

But let us go back to Jack Sharp. He started as a boy working with a dairy herd and is now, at the age of 33, in one of the key jobs in farming. He is, of course, extremely fond of his cows, and although you may hear him loudly uttering the most terrible threats to the animals under his charge, he never lays a finger on them and the cows know perfectly well that it is all bluff. In fact, he has made them so tame that he literally has to push them out of his way when he wants to pass them.

The Herd.

The herd is a typically commercial one. Several breeds are represented, the general idea being that so long as a cow can produce the goods—i.e. milk—it does not matter much what her pedigree is. We must not forget Clarence, the bull. He is a most important part of the herd. Jack and he are not on the best of terms, but more of that later.

A little more general explanation before we get down to the actual job. It may not be universally known that a cow does not produce milk until she has had a calf. The time she continues to give milk after the birth of the calf varies tremendously with individual cows, but if we say that the average time is about 40 weeks, we shall not be far wrong.

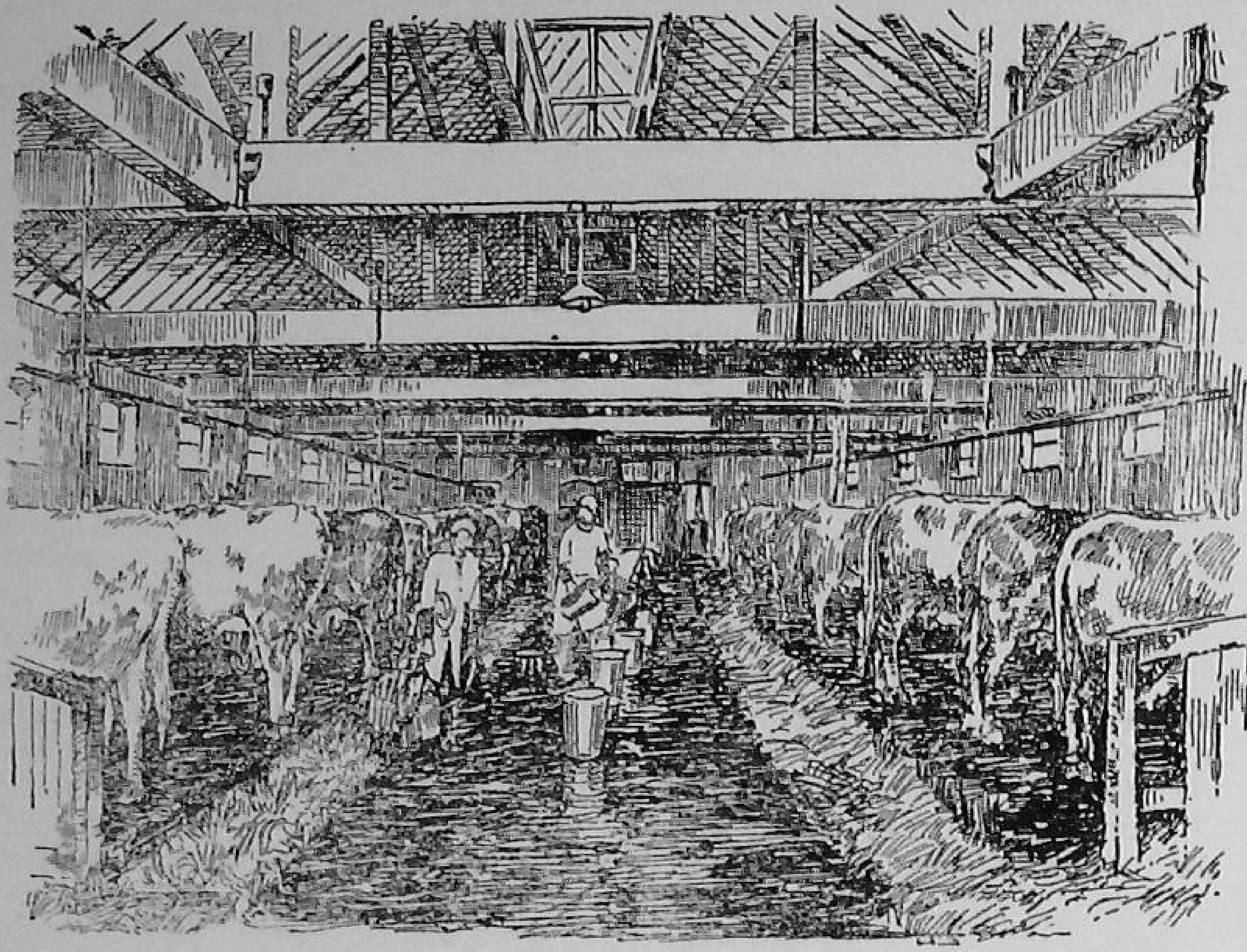
On a well-run farm it is usual to allow the cow to have a rest period of 2 to 3 months between ceasing to give milk and having her next calf. Now the gestation period of a cow—I mean the time from mating with the bull to the birth of the calf—is forty weeks. (It may make it easier to remember this if you know that the gestation period of cattle is exactly the same as in the human race.) You will see that forty weeks of milking, plus a twelve weeks' rest period, total exactly a year, so that to ensure that a cow breeds once a year she should not be mated (usually known as " bulled ") until three months after she has had her calf.

Supply of Milk.

Those who have graduated to higher mathematics will immediately grasp the fact that if you have an equal number of cows calving in each month you ought to have an equal supply of milk every month of the year: In theory, " yes "; in practice, very much " no ".

It should be mentioned that a cow gives her biggest daily yield of milk soon after she has calved and that this yield gradually dwindles until she ceases to produce any milk at all. She then becomes what is known as a " dry " cow.

And lastly, from the general side of dairying: the milk on this farm is sold to a milk retailer (the " milkman " to the townsman) and is guaranteed to be up to a certain standard of cleanliness. Incidentally, this cleanliness is checked frequently by the local sanitary inspector and the cows are examined several times a year by a Government veterinary surgeon, so that cattle that are diseased in any way can be weeded out. The official term for milk produced under such conditions is "Accredited Milk."



THE COWHOUSE

Mr. Bishop.

This is not the place to go into the part played by the owner of this herd—Mr. Bishop—known to all on the farm as " the governor," *we want to watch Jack Sharp*, but it may be briefly stated that " the governor " looks after the business side of the job, the general organization and the management, and he also supervises the whole thing. Jack serves out the cattle-food allotted to him, is in charge of the milking and of the general attention to the dairy herd.

The Work.

Well—Jack Sharp is provided with the cows, the food, the tools and so on: let us see how he gets on with the work.

It is the middle of the winter. The cows sleep in their stalls in the cowhouse every night, tied up round the neck by yokes. In the front of each stall is an earthenware manager and a small bowl with a constant supply of water.

Jack's alarm clock nearly splits his ear drums as it goes off with a bang at 5 a.m. He gets out of bed, has a cup of tea from his thermos flask and hands another cup to his wife who need not get up for a long time yet. His house is only 50 yards from the cow byre so he is soon on the job.

Luckily this farm has electric light. A click of a switch on dark mornings and the cowshed is as bright as day. It holds forty cows and all of them are giving milk in different quantities. There are ten more cows in this herd, the " dry " cows, but these are housed elsewhere, as we shall see later on.

Jack has not seen the cows since 9 p.m. the previous evening. His first job is to walk quickly through the shed and see that the cattle are all right. One glance is quite enough for an experienced man like himself.

Breakfast.

He then starts to give them their breakfast. This consists of a mixture of some concentrated food such as bran, oats, and oil-cake. He has a large barrow full of this mixture and two metal measures which when full hold a known weight of food.

The barrow can be wheeled down the passage in the middle of the shed, and the food taken from it in the measures already mentioned.

Jack stops the barrow at each stall and rations out the correct quantity of food to each cow. How does he know that? There is a small blackboard nailed up on the wall at the top of each stall and on it is chalked the amount of concentrated food each cow should receive. Oh—you did not know that individual cows were rationed? Briefly, the more milk a cow gives in a day, the more concentrated food she receives in a day, and as her milk yield drops this food is cut down and replaced by less concentrated foods such as hay and straw.

We must get back to the actual job. Jack has started giving breakfast to the cows, and it is now 5.15 a.m. In comes the second cowman, Harry Taylor, and another man on the farm staff, David Edge. Harry starts at once to give Jack a hand with the feeding. David's job is to wash

the cows clean. That sounds rather a tall order.

Cleanliness.

In actual fact, the only parts of a cow that must be spotlessly clean are those which might cause the milk to become dirty. The first is, of course, the cow's udder where a milker's hands or a milking-machine would come in contact with any dirt present and probably pass on that dirt to the milk. Next, the cow's tail. She might easily switch it during milking, flicking some mud into the bucket at the same time. And lastly the flanks—particularly the right flank of the cow. Why particularly the right flank? Here is the answer. The milker sits on the right side of the cow when he milks her—in professional jargon this is always termed the " near side "—consequently although it is an undesirable practice to lean the head against the cow in milking, it is liable to happen on this side. It is quite easy to imagine how dirt can be rubbed off the cow by a cowman's head and how it can drop into the milk-pail beneath.

It does not matter very much if a cow's ears are dirty during milking hours; it will not affect the cleanliness of the milk.

Long hair on a cow attracts and holds dirt much more easily than short hair. Therefore, Jack keeps the udders, tails and flanks of the cows closely barbered. He has a special clipping machine and gives the cows a trim up every six or eight weeks.

David has filled a bucket with clean cool water —not hot water—a very important point this, because the use of hot water for washing a cow causes skin trouble and internal complications to the udder.

Ready for Milking.

He dips a cloth in the water, sluices it thoroughly over the necessary parts of the cow and then gives them a good scrub with a fairly stiff brush. More clean water and that cow is ready for milking. The stiff brush may sound rather harsh, but we must remember that a cow's skin is much tougher than the human skin.

The water in the bucket soon becomes dirty. It must be frequently tipped out and replaced by clean. David has forty cows to wash. It will take him about an hour to do this. Then he goes home to breakfast and is ready to report for other duties on the farm at 7 a.m.

Jack and Harry have finished the feeding just before 5-30 a.m., the time at which the actual milking begins.

Milking Machine.

On this farm a milking-machine worked by an electric motor, is used. Now a milking-machine is simply a mechanical contrivance which provides a vacuum exactly equal in " pull " to the sucking of a calf. This " pull " of a calf has been most carefully measured by the manufacturers of the machine and is reproduced by it. Four hollow cylinders lined with rubber are fixed on to the four teats of a cow. By an ingenious arrangement of valves and other devices the suction is brought to play on the cow's teats. The milk flows, passes down a rubber tube to a bucket with a lid on it, and there we are.

Jack switches on the electric motor. Both he and Harry wash their hands in the dairy (using a special basin provided for the purpose), put on their milking overalls and caps and carry the milking apparatus into the cow-shed—a little more routine work before milking can begin.

As every milk-producer knows, cows' udders are, unfortunately, subject to disease. One disease in particular, mastitis, contaminates the milk in the udder, with very nasty looking pus making it quite unfit for human consumption. This cannot be spotted by merely looking at the cow: you must see the actual milk. So before the milking takes places, Jack draws a few spirts of milk from each teat (*he* will say " from each quarter ") onto a black plate fixed on the top of a metal mug. This milk shows up plainly against the black background and if he sees anything wrong with the sample, the cow from which it has come is not milked then, but is left until later, to be dealt with separately.

Well, everything is all right with the first half-dozen cows this morning, so off we go. This particular machine can milk three cows at the same time and it takes from four to six minutes to milk each cow. Thus, including the time taken to transfer the appliance from one cow to the next a machine of this capacity milks about twenty-five cows an hour. Incidentally, it takes a good man to milk eight cows in an hour by hand.

Jack takes the machine from the first cow. In theory she ought to be milked dry. In practice she is not. A cow is able to prevent her milk from flowing whenever she feels like it. After all, she is not being unreasonable. That milk is intended by nature for her calf, why should a mere man be allowed to have it?

The Last Drop.

Anyway, the great majority of cows do not let the whole of their milk down to a machine. This is where Harry steps in. He sits beside the cow on his three-legged milking stool and sets about getting the last drop of milk from the cow by hand. Usually there is not much more to be had, but it is the richest milk of all, and it is *most important* that the cow should be milked dry. Perhaps the warm hands of a human being feel more like the mouth of a calf than do the cups of a milking-machine. I do not know, but a cow gives a little more milk when hand-milked than when a machine is used. And, in all probability, gives more still if sucked by calves, though we have no means of measuring this for certain.

Jack is now ready for the next cow. In order

to make sure that the cylinders (or cups) of the machine do not carry germs of disease from one cow to another, he dips them into a weak solution of chloride of lime, a process by which they are washed and disinfected before being attached to the next cow.

A Cooler.

Soon, one of the covered buckets, holding from 3 to 4 gallons, is full of warm milk straight from the cows. Jack carries it out of the byre into the dairy. Here is another piece of apparatus known as a cooler. Its name describes it; it cools the milk. A stream of cold water is constantly running through a series of pipes made of very thin metal and constructed like narrow organ-pipes lying on their sides. Jack pours the warm milk into a large vat fixed above these pipes, turns on a tap at the bottom of the vat and the milk slowly trickles over the cold pipes which, of course, cool it down to their own temperature. The milk then runs down into a large funnel, and through this into a churn underneath, where it is ready for delivery. On its way down from the vat to the churn is a series of filters, some of copper gauze, others of cotton wool, which take out any impurities.

A Difficult Cow.

Hullo—what's this? Jack is going up to a cow with a strong rope in his hand. Let's ask him what he is going to do.

"Well, it's for Daisy here. Funny tempered cow she is! Sometimes she doesn't feel like being milked and her way of telling me so is to kick out with one of those hind legs; if she hits you it's as bad as a knock from a sledge hammer. Now, I am going to tie this rope right round her body very tightly just in front of the udder—by the way, on a farm we always call an udder of a cow 'the bag' and when the udder is full of milk we say a cow is 'bagged up'—but about this tight rope: it gives her an uncomfortable feeling and at the same time seems to numb the muscles which control her kicking apparatus. She forgets her grievance about being milked and then I can get on with the job."

A Case of Illness.

About 6-30 a.m. in comes Mr. Bishop. "Morning, Jack, morning, Harry. England seems to be doing well again." "Yes, governor, I think we shall win this match all right," says Jack. "Now, you'd better have a look at Camel down there in stall 25. She hasn't eaten any breakfast and her milk yield is down a lot." He makes a special point of telling the governor about anything wrong before the latter finds out for himself. After all, it would be rather a black mark against a specialist if he himself had not spotted a case of illness.

Two heads are better than one, and in the great majority of cases, Jack and the governor will soon diagnose the case and decide on a promising treatment.

Milking is finished now. Harry takes off his milking overalls and gives the cows their morning hay ration in the same manger as before. Jack rinses out all the buckets, milking-machine parts and cooler in cold, clean water, writes out the labels to be fixed on the churns, puts the lids on the churns and seals the catch with wire and a lead seal. Everything is now ready for delivery. Just at this moment the milk van arrives, up go the churns, off goes the driver and with him another consignment of first-class milk produced under perfect conditions.

Drenching a Sick Cow.

Jack takes off his milking overalls, which are frequently cleaned and which he always wears when he has the slightest contact with milk. He helps Harry to feed the "dry" cows which are kept in another shed. On most mornings they would go off to breakfast now, but to-day there is still the sick cow to be doctored. Mr. Bishop has diagnosed digestive trouble and has prescribed an aperient medicine. Jack pours a pint of this into a long-necked bottle and with Harry's help proceeds to give the drink to the cow. The farming expression for this is "drenching a cow."

The medicine has a nasty smell and a horrid taste. No self-respecting cow would dream of touching beastly stuff like this however ill she might be. It must be given forcibly. First of all, Harry walks up to her from behind, catches hold of one horn with one hand and twists her head round towards him. Then, with the thumb and forefinger of the other hand he catches her by the nostrils. The cow is completely helpless now, she cannot even struggle very much. Jack now comes up with his bottle of medicine. He takes hold of the nostrils with his free hand in place of Harry who can now hold both horns to stop the cow from shaking her head. The cow's head must not be turned to one side when "drenching" or she may choke when the medicine is poured down her throat. Jack puts the end of the bottle into her mouth and gently pours the liquid on to the tongue. The cow swallows it without difficulty.

And now for breakfast and the eight o'clock news!

Routine Jobs.

After breakfast our two friends arrive back in the cowhouse. There are one or two routine jobs to do first. Two cows need their "bags" and flanks clipping, as the hair has grown rather long; about 10 minutes suffices for this. Then all the healthy cows in milk and the "dry cows" are turned out of the sheds onto the pasture near the buildings. It is winter time, there is of course no grass in the fields for them to eat at this time of the year but the cows need exercise every day and it is much easier to clean out the shed when

it is empty. The two men lean over the gate leading into the field and stand watching the cows for a few minutes. Why? Jack will explain. " We want to see if any cows are 'on bulling.' Oh—you don't undertand that? Well—to see if any cows are in season or ready to be mated with the bull. Yes—there is one. Can you see where that cow has mounted the back of the other one? The underneath cow is standing perfectly still and obviously likes it, she is 'on bulling'."

A cow comes " on bulling " every three weeks and remains in that frame of mind for about one day. She will only mate with the bull at that time, and, of course, ceases her three-weekly period when she becomes pregnant.

Mr. Bishop has already arranged with Jack about which cows are to be put to the bull next. What he actually said was " When Blossom, Ladybird, Laura and Gandhi come on next time, we'd better have them bulled, Jack."

Clarence, the Bull.

The cow in the field has to be brought back to the buildings to the bull yard. Clarence, the bull, a nasty customer incidentally, has heard her footsteps from his pen where he is always kept tied up securely. He knows very well what is happening and gives vent to his feelings by a series of roars and bellows, rather like those of a lion. It is not safe to take any liberties with him. Jack takes a " bull staff " into the loose box. Clarence has a stout copper ring in his nose: it has been bored through his nostrils when he was about a year old. The " bull staff " is a strong pole about four feet long; at one end of it there is a metal clip which can be fixed on to the bull's ring. When this is secure, Jack unchains him and leads him out to his bride. The date of this is carefully recorded both in Jack's dairy book and on the back of the little black-board in the cow's stall. Thus, if all goes according to plan, the date of the birth of this particular cow's next calf is known.

Cleaning and Washing.

These sundry little jobs finished, the two men go ahead with cleaning out the cowhouse and the washing of the milking equipment. Jack has an electric boiler in the dairy. He switches it on and while steam is being made, gives Harry a hand with the shed. All mangers are cleaned out first, then the water bowls, which are fixed in the stall in front of each cow; lastly the stalls themselves and the dung channel into which the cows excrete most of their dung. The soiled bedding and manure have to be taken out of the shed in a wheelbarrow and afterwards the whole place is thoroughly washed out with the brooms. Harry brings in fresh litter, generally wheat straw, whilst Jack goes to the dairy to deal with the equipment. All metal or rubber parts which have come in contact with milk are scrubbed in hot water and soda, and after being cleaned are sterilized in a steam chest for two minutes. Then Jack goes round to give Clarence, the bull, his morning walk. With such an uncertain-tempered animal as this, it is best to take every precaution. A large metal mask which blindfolds him, is strapped over his head, the " bull staff " is fixed and off they go for half an hour's exercise. Harry goes to the haystack to cut out the necessary number of trusses for the next day's feed.

Dinner-time already, the morning has gone in a flash!

The Afternoon.

In the afternoon, the milking-machine has to be re-assembled, the cooler put back in position and the afternoon's ration of concentrates and man-golds put into the mangers ready for the cows when they come in for milking. The key-note of milk production on this farm is spotless cleanli-ness. Jack knows that if even a small portion of the equipment is not absolutely clean, it can send the whole of the milk sour. He has never had a faulty sample of milk during the six years over which the authorities have been subjecting it to the most exacting tests.

By 2 p.m. everything is ready for the afternoon's operations.

In come the cows. There is a volume of threats from Jack which in practice boil down to nothing, a locking of the yokes which tie the animals up and a steady munching sound as they tackle their food.

The passage down the middle of the shed has been dirtied by the cows' feet. We cannot expect clean milk if the floor is not washed again. The cows' " bags " must all be washed once more, but there is no third man to help in this job for the afternoon milking.

Second Milking.

At 3 p.m. the second milking of the day begins with exactly the same routine as that of the morning. It is finished by 4-30 p.m. when Harry gives the cows their ration of hay for the night and Jack washes up the equipment in cold water ready for to-morrow morning. It is 5 p.m., out go the lights and another day's milking is finished.

Just before bedtime, Jack Sharp will have a final look at the cows. He would not be human if he had not a favourite among them. Yes—there she is, old Granny. No one is watching. What if he is breaking all the rules of scientific rationing? Old Granny is to have a small extra feed of dairy cake. Just a secret between the two of them and the old cow licks Jack's hand in appreciation. Would Mr. Bishop be annoyed if he found out? Of course not. He would probably do the same if he had Jack's job.

Once a week the morning's milk as well as the afternoon's milk from each individual cow is weighed and recorded on a sheet specially provided for the purpose. This is, of course,

essential for two reasons. Firstly, the exact milk of a cow must be known before it is possible to feed her correctly, and secondly, a scrutiny of the record sheet will tell how much milk the cow has given during a lactation or milking period. Of course these calculations are part of Mr. Bishop's own work as a farmer.

The Summer Months.

During the summer months the routine of the cowhouse differs somewhat from that of the winter months. The actual times for milking remain the same, but the feeding is entirely different. The cows sleep out in the pastures every night and as there is little mud during the warm weather the cleaning of the cows is much less laborious.

The main food of the herd is now the fresh growing grass in the pastures. Hay, mangolds and most of the concentrated foods are unnecessary. Jack can manage the daily cleaning of the shed by himself in summer. Harry continues to assist with the actual milking, but goes to other jobs on the farm after breakfast until mid-day and again after dinner until the cows are brought home for the afternoon milking.

An Awkward Accident.

One beautiful summer morning, about 10 o'clock, a man who is having a country ramble, rushes into the shed, sees Jack, and says, " One of your brown cows is stuck fast in a pond up at the top of that field." Jack thanks him for the information and promises to attend to it at once. He is, of course, much too polite to make the obvious rejoinder. *There is no such thing as a " brown cow " on a farm;* there may be a public house of that name in the nearest village, but cattle which appear to the layman to have that colour, are invariably termed " red cattle " in agricultural circles.

However, we cannot thrash that point out whilst the cow is drowning. Jack gets a good strong rope, shouts across to four of the farm staff, who are fortunately working in a field close by, to come and help, and sets off for the pond. It is rather a muddy pond which has been fenced off from the cow pasture. Somehow or other the fence has been broken, hence the accident.

Yes—Giant, one of the biggest cows in the herd, is well and truly stuck in the pond. Her legs are right down in the mud and the water over the mud is nearly up to the top of her back. Jack makes a noose at one end of the rope, drops it over Giant's horns and draws the noose tight. Half a dozen strong men give a united heave. It does not seem to make much difference. Poor Giant has exhausted herself with struggling and lies like a log.

" But won't you pull her head off? " asked the townsman. The men are much too busy to explain that such treatment will not even hurt the cow, much less pull her head off. " Come on again," says Jack. " All together. Pull. And again, pull! " They get her out by degrees but it is fully an hour before Giant is on dry land again. The men would be delighted to have the real " Brown Cow " just round the corner now, it has been very warm work. When the governor hears about this he says to Jack, " Must have been the flies tormenting her that drove her into the pond. We had better give the whole lot another dressing of derris." What does he mean?

The Warble Fly.

Now the fly that causes cattle to stampede in warm weather is called the Warble Fly. The animals seem to be terrified by it; and this is a mystery which has not yet been solved by anyone: the fly does not bite them, it simply lays its eggs in their hair. The eggs turn into maggots, penetrate the skin and live inside the animal. In about nine months' time the maggots bore through from the inside of the skin on the top of her back. By this time the grub has grown to a length of about three-quarters of an inch, and it is nearly as much in circumference. It has an exceedingly tough skin of its own. It takes about a week for this grub to bore a hole through the cow's skin and to pass through this hole itself. The grub then falls from the cow's back on to the ground where, in due course, it changes into a warble fly and thus we have the complete cycle.

It is now compulsory by law to apply a liquid wash, containing derris powder, every two or three weeks from March till May, to the backs of all cattle. This kills the grubs which have just poked their noses through the skin and the smell of the liquid seems to keep the warble flies, which may have hatched out, away from the cattle.

Other Troubles.

Are there any other troubles likely to crop up? Rather; Jack has plenty with a herd of fifty dairy cows. He considers himself lucky if he has a week without something or another wrong. The majority of the troubles are quite minor ones: a thorn in a cow's foot, cuts and bruises, especially on the udder. But then there are the more serious affections: udder diseases, abortion (a dreadful complaint if it is of the contagious variety), stomach troubles, lung and other troubles, not the least of which are the cases of difficult calving; and these certainly call for a high degree of skill.

A calf is born head first, with its forefeet touching its nose, just as if it were about to take a dive, in fact. What are the complications? The principal ones are those where one or both forelegs are bent back, or the forelegs are pointing forward but the head is turned back, or the calf is born tail first (not a very difficult case that), or there may be twin calves with their legs mixed up anyhow. The cow must receive attention in all these cases. Let us ask Jack for a few words of advice in general on this complex question.

Calving.

"Now—the first, second, and third rules are all the same," he says. "Give the cow plenty of time before you start doing anything. More cows are killed at calving by men being too impetuous and starting operations before the cow is ready than from any other cause. If you have to put your arm more than wrist deep inside the cow before you can feel the calf, she isn't ready for calving. In fact, I prefer to wait until I haven't to feel inside any more than finger depth, but there are exceptions to this. Of course you mustn't wait too long, or the cow's passage will begin to swell up and then you'll never get the calf away at all, and you lose the mother into the bargain. Quite often the mother's passage is on the small side whilst the calf has a big head (although it may be lying in the correct position for birth) and I really believe that those are the most difficult cases of all. Lastly, it is really surprising how much easier the actual calving is for the cow if she has been fed correctly for three months before she calves."

Difficult Cases.

We shall watch Jack as he deals with one of these difficult cases. First of all he thoroughly disinfects his hand and arm before making an internal examination. Yes—the cow has been calving quite long enough. She will never expel the calf without assistance because the calf's head is big and jammed in the cow's passage, which is small. Everything else seems to be in order and the forelegs lie just inside the passage. Jack takes hold of one foreleg of the calf and pulls. This will straighten the leg and make the foot come outside. The same with the other leg. The calf's head, however, is still completely jammed in the passage. He then ties a strong cord round the ankles of the two forelegs of the calf. Incidentally, the mother will, in all probability, now be lying down and her efforts at childbirth will have made her perfectly easy to handle. In all other cases, particularly when the cow is still wild, she must be tied up by the neck to a post or some other immovable object.

Jack has got his rope onto the calf's legs. He must have some assistance here, two extra men are best. The helpers give a united pull. Yes—with all their strength. *Of course* it hurts the cow, but these men are not brutes. It is a matter of life and death now and anæsthetic would simply stop the mother from using her muscles to help in expelling the calf. The men try to time their pulls with each spasm of expulsion which the cow has. And this is most important, the direction of the pull must not be straight out behind the cow, it must be more or less parallel with her hind legs in a downward direction.

Whilst the men are pulling, Jack has one hand inside the cow's passage just where the crown of the calf's head is wedged. He has inserted a plentiful supply of grease, and with his fingers is doing his best to stretch the soft skin inside the passage. With each pull the calf's head comes forward a little more until at last the whole head is out of the cow. From then onwards it is easy. Merely a matter of two seconds before the whole calf is outside.

Its First Breath.

The newcomer lies on the ground with no sign of life. Has Jack made a mistake? Has his policy of waiting been carried on just that little bit too long? No—the specialist does not often go wrong in that. He gives the calf a resounding slap on the ribs, wipes the slime from its face and nose, opens its mouth and blows down it, whilst one of the helpers gently moves the little legs (all of them) backwards and forwards. A tiny sneeze, a rather louder cough and the calf has taken its first breath. Within a minute the little thing has lifted its head and given it a good shake. It will be all right now.

But what about the mother? She is lying fully stretched out and completely exhausted. As soon as Jack is satisfied that the calf is breathing properly, he carries it to its mother's head. And what a transformation! The half-conscious cow comes to life at once and starts licking her baby. With each lick the calf becomes more vigorous and the cow more alert. But she is still lying down. After a quarter of an hour it is imperative that she should stand up or her limbs will stiffen, and it may be days before she can get up. Pushing, pulling, heaving, blowing into her ear, all the tricks of the trade are tried, but this is really an obstinate case. As a last resort, but only as a last resort, Jack plays the ace of trumps. He brings his dog into the calving box. Up jumps the cow at once to protect her baby. Men are her friends, here is an enemy. The very sight of a dog to a cow with a young calf will nearly send her mad, and in consequence the "dog trick" should not be used except in extreme cases. If Jack's high card has not won the game, the cow must be on the point of death.

Feeling of Pride.

Jack Sharp has calved hundreds of cows, you might think that it had become routine work with him. But even if he lives to be ninety he will never lose the inner feeling of pride that his artistry has saved two lives. He has lost many a night's rest on maternity work and has had his usual work to do on the following day. Does he begrude it? Not a man of his calibre.

What of post-natal complications? Septicæmia, milk fever and retention of the after-birth by the cow are the commonest. Septicæmia is, of course, always dangerous. Milk fever under modern veterinary treatment can now be regarded as a minor complication although the percentage of mortality from this disease was terrific until less than forty years ago. Retention

of the after-birth is also not a serious thing, although the "cleansing," as it is called, should not be taken away by hand earlier than three or four days after the birth of the calf. Of course a cow should normally "cleanse" within a quarter of an hour of parturition and here lies the only point of divergence of opinion between Mr. Bishop and Jack. Most cows will eat their own "cleansing" if given the chance. And very disgusting it is, too. Jack thinks that this should not be allowed and would like to take the "cleansing" away as soon as the cow has got rid of it. He imagines that a cow might choke herself with it. Mr. Bishop says "No—I think the cow should be allowed to do what nature obviously intends. Cattle are not carnivorous animals and there must be some strong natural reason to make a cow do such a thing. I believe that there is some antidote in it against post-natal complications. We certainly don't have as much trouble from such causes as many herds. As for choking, I've had several thousand cows calve in my career and no cases of choking so far!" We do not know which of them is correct.

. . . . .

Well—those are some of the ramifications of up-to-date mechanised milk production. It is a case typical of thousands of the dairy farms in this country. The next time you pour your milk into your tea, will you give a thought to the men who do the job of producing it for you?

Is dairy farming an arduous job, you ask? Yes—very. Monotonous? Not by any stretch of imagination. How could it be? *The cows are living creatures.*

THE SHEPHERD

This section introduces us to Charles Stanhope, K.C., a friend of the "the governor." Ned Trumper is the shepherd. The circumstances of his work, his exceptional character and his dog are all mentioned. The farmer and his lawyer friend set out with Ned. They see the intricacies of "lambing": The day's work begins with feeding, after which a tour of the field is made and Ned demonstrates the way in which both routine jobs and difficult cases receive due attention. Other work among the lambs is explained, including tail-cutting and castration. Blow-fly attack and intestinal worm infestation are considered. The method of "drenching" sheep is described. Accounts are given of shearing and wool-disposal. The treatments for foot-rot and other ailments as well as preventative measures are discussed. Lamb sales provide Ned with a welcome change from work on the farm.

New Born Lambs.

"I SEE that you have some new-born lambs, James. There can't be many people who don't get a thrill from seeing lambs frisking about in the springtime. Yet I don't suppose they just happen—is there much planning and work connected with a breeding flock of sheep?" It is Charles Stanhope, a well-known K.C., speaking; he has recently taken a house in the country close to the farm of his old school-fellow, James Bishop.

"Why, of course there is, Charles," says Bishop. "But why not spend a day with the shepherd and me to-morrow. We're bang in the middle of the lambing season and we can answer quite a large part of your question on the spot. Can you get here just before dawn? I'll arrange with Ned Trumper to wait for us."

And that is just what happened.

"Grass" Sheep.

A short account of Mr. Bishop's sheep will not be out of place before we get down to the actual business. The flock is composed of what are known as "grass" sheep, that is to say, they spend the whole of their lives on grass land (or pasture) as distinct from "arable" sheep which are folded during the winter on root crops grown on ploughed land, technically called "arable land." Obviously a "grass" sheep is of a hardier type than an "arable" sheep. It does not get the juicy, succulent foods (such as kale and turnips) which are grown on ploughed land, yet it manages to thrive on grass all through the winter with a small additional feed of corn or oil-cake and perhaps hay. Nature takes a hand here. The "grass" flock does not, as a rule, produce as many lambs to each ewe as the "arable" flock, so that there is not as much strain thrown upon the mother when she is either pregnant or producing milk for her offspring.

A Fortunate Shepherd.

Ned Trumper is rather more fortunate than some shepherds. The farm is in the south of England. He is more favoured by the weather. In fact, when the lambing begins in the first week of March, the worst of the winter is gone and he need not bring his flock into a special lambing pen at night as must be done where snow is to be expected. In the second place the ewes are of the famous Romney Marsh breed, but the rams are pure bred Southdown sheep. The Southdown sheep is smaller than the Romney Marsh. "What's that got to do with it?" Well—in short, where the father is of a smaller breed than the mother, the lamb is on the small side and this makes for much easier parturition. In many parts of England the rams are of a bigger breed than the ewes and in such cases lambing is a difficult job.

The governor's friend, Charles Stanhope, has not lived in the country very long but he keeps his eyes open and is keen to know of the things which go on around him. He arrives in good time the next morning and goes off with his friend to meet Ned.

Master and Man.

Now Ned is a character, and a very exceptional type of farm labourer; a man of forty-five who has spent his life on a farm, he is a great reader. All sorts and kinds of literature are meat and jam to him. His favourite author is Dickens, but he can discuss most of the modern novelists as well. He began on Mr. Bishop's farm when he was a boy and has learnt all he knows about sheep (and that is a lot) from the master. Yet to hear him talk, you might think that the governor was a complete amateur with them. However, they understand one another thoroughly and as neither talks about Ned's apprenticeship, everyone is satisfied.

Here is Ned, complete with his dog, Kruger (another character like his master), his shepherd's crook and a haversack containing disinfectant, a bottle of hot milk, a pair of shears, and sundry sheep medicines.

"Morning!" says Ned. "I'd nearly given you up as a bad job and set off without you. Must get down to those ewes at once."

It is still so dark that you cannot see five yards ahead, but Ned is all impatience to be off, so this remark of his raises no comment. The fields in which the flock (some 300 in number) is kept are only a quarter of a mile away. The little party is soon there.

To break off for a minute. As soon as each ewe has had her lamb or lambs, or rather when the lambs are about forty-eight hours old, she is taken out of the field with her offspring and moved to another. This latter field has not been grazed by sheep all winter and there is quite a

SHEEP FARMING

good growth of grass in it. This extra bite helps the mother to produce the milk for her young.

The Lambing Field.

Here we are at the gate of the lambing field. "Lie down there, Kruger," says Ned. "I don't expect that we shall need you to-day." Kruger knows all about this, and down he goes. No one but Ned could make him move and he will stay just where he is all day in default of further orders.

In the middle of the field are twenty long wooden troughs and near them a large corrugated iron shed built on wheels. Inside the shed is the food: corn, oil-cake, and chaffed oat-straw, all mixed up ready in bags for feeding.

It is still quite dark—and it is quite impossible to see the sheep properly yet, but not too dark to begin feeding. Ned goes along the line of troughs, tips each one over to make sure it is clean and brings a bag of food from his shed. The sheep have heard him all right; within a minute he is surrounded by sheep pushing and scrambling to be first at the trough.

"Now then, what are you up to, you old——" shouts Ned as one ewe gets entangled with his legs and nearly knocks him down. A waste of breath really, it is breakfast time and trivialities like this do not concern the sheep.

At last the food is safely in the troughs to the accompaniment of a running commentary from Ned concerning his lurid opinion of greedy animals.

"I like to talk to the old girls when I'm amongst them," says Ned, with a perfectly straight face. "I think they like it and it does not matter much what you say." He's quite right there, all animals like to be spoken to and what a difference it makes when they are handled.

It is getting quite light now. You can nearly see across the field. Ned gives a loud shout. "Hoy! Hoy! Hoy!" Just to make certain that no sheep are unaware that it is breakfast time. There are still about twenty sheep dotted over the field, but they take no notice of the call. Why not? Ned will tell you.

"When a lamb is newly born, its mother will not go more than 20 or 30 yards away from it, no matter how hungry she may be. If she does, she's a d——d bad mother. Those sheep out on the field have had lambs during the night or perhaps are about to give birth. At any rate, we must have a look at each one of them at once."

Round the Field.

Ned slings on his haversack, picks up his crook and off we go round the field. The first ewe we come to has just had a lamb. It is covered with a yellow slime, and its mother is busy licking it clean. She stamps her foot at us as we approach, and you can see from the look in her eye that she is very upset. Kruger has been left at the gate for fear of making matters worse.

"Now, girl, I don't want to hurt you," says Ned. "But I must have that lamb for a second and I want hold of you."

He picks up the lamb by the forelegs, pours a little disinfectant on the broken end of the navel cord as a precaution against tetanus and puts it down again. The ewe has been standing back at a distance of about five yards. This is where the shepherd's crook comes in. The mother will go back to her baby in a minute. Ned creeps up behind her with the crook in readiness. A slight lunge with the crook and he has it round her hind leg. A small pull and he has caught the sheep.

"Is that really necessary? Surely she's had her lamb, there cannot be a reason for upsetting her any more," asks Mr. Stanhope.

"You don't think I'm making myself any more work than necessary," says Ned. "I want to look at her udder to see that she has plenty of milk and secondly, I notice that she has not

cleansed. Or, if you like it better, her after-birth hasn't come away. She will not do that if she has another lamb inside her, and I want to make certain that if she has, the lamb is lying in the correct way so that she can get rid of it herself. If it is lying the wrong way in the womb, I must straighten it out myself or she'll never get it away unaided."

The udder is all right. Ned pours disinfectant onto his hand, feels very gently inside the uterus, pronounces everything to be correct, lets the sheep loose and off we go to the next one.

This ewe has had her lamb several hours ago. The after-birth is lying on the ground. She won't have any more lambs this year. All we need bother about is whether she has enough milk for the lamb. No need to catch the sheep to find that out. Ned picks up the lamb by the forelegs, disinfects its navel cord and looks at its little stomach. You might think that its belly would burst, it looks so full. That is as it should be. A lamb will suck from its mother within five minutes of birth. It is not a gentle little suck, but a long, gluttonous, greedy feed. Ned will tell you that once a lamb has had that first suck and has filled itself, you are a long way on the road to rearing it successfully.

Something Wrong.

"Ah! here's something wrong. A ewe with two lambs. One seems to be full enough, the other's stomach is all caved in. Catch the ewe. Try her udder. No milk. Do you remember the hot milk that Ned brought with him?" He fits a rubber teat in the end of this bottle, puts the lamb between his legs and proceeds to feed it from the bottle. The little thing is ravenous. When its belly looks nice and round, Ned stops. The lamb would try to drink the bottleful if he let it and would probably kill itself in doing it. If it were sucking milk from its mother, she would know, by the slackening of the tightness in her udder, when the lamb had had enough and would refuse to let it suck.

"I'll leave this youngster with his mother for the time being," says Ned. "She'll look after him all right, and I may be able to find a foster-mother for him later. In any case, I shall feed him from a bottle until I do."

"But how do you know he won't suck his brother's milk when he gets hungry?" asks Mr. Stanhope. "You may have to find a foster-mother for the other one instead."

Unwritten Law.

"No—that won't happen," is Ned's reply. "You see, a ewe has two teats. If she has two lambs, she always prefers one and she will always let her favourite have his fill before the other. More than that, within a very short time, it is an unwritten law that each lamb has his own teat. Perhaps the mother has plenty of milk in one teat and very little in the other. That doesn't help the lamb on the short rations. The old girl knows. Oh, yes—some lambs get artful and sneak up behind their mother and suck from between her hind legs from the wrong teat. Exceptions prove the rule. We shepherds would soon be out of a job if the lambs could fend for themselves like that."

"How does a ewe know her own lamb or *vice versa?*" "By smell only. Perhaps when they get older the mother and children recognize each other's voices. But in the beginning it is scent alone."

We haven't seen many of our sheep yet. We must push on. There are some more difficulties cropping up.

What's this? A little lamb, still covered in its initial slime. No mother has licked it clean. Here is a picture of misery, no mother, no food, nothing; a helpless little scrap. Now this is where Ned really proves his worth.

Dear Fido.

In the first place, the lamb obviously has a mother somewhere in the field. *She* may have had two lambs. Perhaps this is her first one and whilst she was mothering it, a dog came into the field. Oh, no—the dog was not a sheep-worrier, rather a friendly dog in fact. But what did the sheep think? It gave her a most awful shock.

She was even so scared that she left her baby and ran away. Do not forget that she could not pick her baby up and take it with her as a woman might. Now, listen to this, you people who take dear Fido for a walk in the country or let him loose at night. Of course Fido would not bite a sheep, he is rather frightened of them in fact, but what has he done to the sheep? Let us follow this poor little lamb.

The mother has been badly scared, she has left her baby before she has licked him properly. Fido is still smelling round the field and the mother sheep begins to feel the pangs of birth of her second child. You cannot stop birth. The ewe has her second lamb and settles down with it. She has not licked her first lamb properly, she has forgotten it.

"Here, governor, I know all about this, let me have a go!" says Ned.

We had nearly forgotten the specialist. He knows how to handle this. But if he can catch the owner of Fido, you will hear something that will have to be deleted by the censor.

Finding The Mother.

Ned has a good look at the lamb. He can tell, by looking only, whether it is an only child or one of two or more. Perhaps it is an only child. The sheep without lambs are still eating their breakfasts. The expert's eye on them will know which one has lambed. Catch her. Suckle the lamb and stand back. Perhaps she is a sheep without the maternal instinct (and there are some like that). If she still does not like the lamb and Ned

is now sure that she is the mother, she must be shut up in a pen with her child and must be held fast several times a day to let the lamb suck. As a rule, she will take her lamb after a couple of days.

But suppose that Ned has decided the lamb is a twin or one of three. Now he is up against it! He must examine all the lambs in the field to find out which of them is the brother (or sister) of the odd lamb. He can never be quite sure of this. No one is infallible and it is very difficult to make a sheep do what it does not wish. In most cases, he will give it up as a bad job and rear the lamb on a bottle in the hopes of finding a foster-mother later.

Warmth Works Wonders.

There are lots of other snags yet. We find a ewe with two lambs. One is standing up and sucking its mother. The other is stretched out on the ground and barely breathing. The mother is licking it and obviously very perturbed about it. Ned puts his finger in its mouth. It feels like ice. Death is not very far off. But there is just one chance. He carries the lamb home and puts it in front of a roaring fire. If this does not do the trick, nothing will. Yes—the pendulum has swung in the right direction. In about two hours' time, the warmth of the fire has brought back life. A good suck from the bottle and the lamb is walking round the room. Back to mother. She may have forgotten her new-born child or she may not. If she has, *this* will be just one more lamb on the bottle.

But we still have not seen all the sheep. "Is that lamb alive?" "No—it's dead." The ewe is still licking it. She does not seem to realize that it is dead. Well—that is part of the bad luck of keeping breeding sheep. But it has one advantage. We want a foster-mother for that lone lamb. Ned takes the skin off the dead lamb, fits it over the foster-child like a glove, and shuts up the foster-mother and child in a pen. She does not know the difference. Sheep go by smell, you remember. In four days' time you can take the old skin off and everyone is happy.

Dead Sheep.

"More trouble?" "Afraid so." Here is a dead sheep. She is lying flat on her back. The lamb or lambs inside her have made her nearly as broad as she is long. She must have rolled over when she was lying down. On her back the circulation goes all wrong. She cannot wriggle upright again and in a few hours she is dead.

Surely there cannot be any more difficulties? Ned would be delighted if there were not. "What is that ewe doing in the corner of the field?" She keeps pawing the ground, lying down, heaving, getting up again but always staying in the same place.

"We must catch her and make an examination. Yes—she's started lambing all right. But what is wrong?" Here is Ned's report.

"For your benefit, Mr. Stanhope, a lamb is born head first, and his two forelegs are stretched out in front of him so that his toes are touching his nose. When he's laid like that, the ewe can generally get rid of him herself, although there is a membrane stretched over his head, and if that has not been broken during birth, he cannot breath when he is born and dies at once. Now this lamb is laid wrong. His head is there all right. But his legs are doubled back. The ewe cannot possibly get him away. I shall have to put my hand inside and pull those forelegs straight."

For all his cursing and swearing, no one could be gentler with a sheep than Ned. He knows. Nothing more need be said.

Another Field.

But we have not finished the round yet. In another field are all the ewes with lambs more than two days' old. They are admittedly on a much better pasture, but the grass is not growing much yet and extra trough feeding is still required. Ned has a routine rather like the one we have already experienced—food in the troughs—more backchat with the sheep in his own vernacular.

This time *all* the sheep come up to the troughs. The lambs are more than two days' old and mother dare leave them for a short time. "No—that's wrong. There's a sheep over there which hasn't come up to feed. Her lamb is close to her and both look pretty sick." We catch her and examine her. She has cold in the udder. One teat has turned black and she is obviously in great pain. Ned takes out his knife and lances the affected part. Horrid black matter oozes out. She will probably live now, but the lamb will be short of milk. It will be another one to feed on the bottle.

His Food.

Whilst the ewes are feeding at the troughs, the lambs are running races and generally playing the fool in the background. "Why is that lamb looking so miserable? He was all right yesterday. Nearly sure to be his food." His food means his mother. Now who is his mother? Let's ask Ned.

"There she is, she has a bit of dirt on her left shoulder," say Ned.

"But surely it's impossible to know," says Mr. Stanhope. "In the first place, all these sheep look alike to me, and in the second place how on earth do you know which sheep is the mother of any particular lamb?"

"Now, I must interrupt you," put in Mr. Bishop. "Ned has 300 ewes. You can take out any one sheep and put it among 1,000 other similar sheep. He will know it. How does he know? I cannot put it into words. But if I were shepherding these sheep I should know, and

I'm certain he does. Dash it all, they all look different to a real shepherd."

"Yes—the governor's right. I know 'em. But we must have a look at this ewe," says Ned.

The mother of the sickly lamb is caught and examined. Right across her udder, caught in the wool is a nasty prickly thorn. She must have collected it round the hedge side. At any rate, each time the lamb tried to suck, his nose was severely pricked and at the same time he pushed thorns into his mother's udder; consequently he has had no food.

How time flies: it's 8 a.m. now. We all go home for breakfast.

After breakfast, Ned must bury the dead sheep after skinning it, or at the least pulling off its wool. He moves the ewes with lambs that are old enough, to the new pasture. He feeds his sickly lambs again. He mixes up the food for the sheep and carts it down to his shed. He keeps a general eye on the ewes and at mid-day goes home to dinner.

This afternoon, he has a very important job to do, and something that he cannot do single-handed. All lambs aged about ten days must have their tails cut short and the males must be castrated.

"I can see why the males are castrated, but why cut their tails short?" asks Mr. Stanhope.

The Blow Fly.

"I can answer that one fairly easily," says Ned. "Sheep are not very clean animals, unfortunately, and to put it in blunt English, are very apt to dirty their trousers. Why does that matter? Well—I'll tell you. During the hot weather the blow fly wants somewhere to lay her eggs. And she always chooses a place where her children can find something to eat when they are born. Preferably flesh. The smell of dung on sheep seems to give the blow fly the sign for which she is looking. The longer a sheep's tail, the longer space of soiled wool. We try to make these dirty trousers as small as possible by cutting the tails short. Can you suggest anything better?"

. . . .

The Lamb Creep.

When the lambs are about a month old, they begin to eat food themselves. Grass, anything palatable. Now, the object of keeping this flock is to produce good lambs. Consequently we do not want the greedy old mothers to have all the tasty bits. Ned fixes up an enclosure with entrances large enough to admit a lamb but too small for a ewe. Inside the pen are galvanized iron troughs, to each of which is attached a little roof about a foot high. The food, generally a form of oil cake, is put into the troughs. The little roofs keep the food quite dry and the lambs go in and out of the pen at their leisure. This pen is called a lamb creep.

If one carried out all the scientific advice connected with sheep-rearing and fattening, inoculating them and giving them pills, medicines and so on, it would be a full time job all the year round.

The intelligent husbandman appreciates that, in practice, one simply guards against the most prevalent complaints and waits until the more obscure diseases crop up before tackling them.

The Worst Complaints.

Ned Trumper's precautions are typical of very many sheep farms. Here they are. Amongst the worst complaints are intestinal worms—which occur all the year round—and the blow fly's eggs in the warm summer months; these eggs hatch as maggots in about twenty-four hours, and the maggots immediately start eating into the flesh of the living sheep. The eggs are generally laid round the tail of the sheep or on the shoulders. In neither case can the sheep do anything to get rid of them.

First of all, Ned's precautions against worms. The lambs are about six to eight weeks old. They and their mothers are put in a large pen together. And a difficult job that is.

Ned, Kruger, and two men as extra helpers are nearly worn out by their exertions. The sheep are all mixed up higgledy-piggledy. The fond mammas have completely lost their offspring. The old ladies in front are sure that the children are at the back of the crush, those in the back are equally determined to look for theirs in front. So there are deep-voiced bleats from the ewes, shrill ones from the lambs; bad-tempered shouts and curses from the men. Poor Kruger has barked himself hoarse and is worn out, dog-tired in fact. By sheer pushing and shoving, the job is done at last. Now the real business begins.

"Drenching."

Ned has a large bottle full of a mixture of copper sulphate and nicotine, or some other reliable up-to-date antidote, a small bottle marked off in notches on the side and a small funnel which he sticks into the small bottle. A boy pours the liquid into the bottle, so much for a lamb and so much for a full grown sheep. Ned stands near the gate of the pen and one of the men brings up a sheep to him. He holds it under the jaw with one hand, puts the end of the bottle into the side of the sheep's mouth and gently pours the liquid in. The other man holds the sheep's tail to stop it from going backwards. Ned holds up the head until the animal is looking at the sky and the sheep swallows. An amateur must not do this or he will probably choke the sheep. When the drink has gone, the sheep is turned out of the pen and the next one is brought up. The technical term for giving medicine to any animal is "drenching." Three men and a boy will comfortably drench 100 sheep an hour. Worm drenching is carried out from four to six times a year according to the type of land being grazed

and the condition of the sheep. It must be mentioned that some types of intestinal worms will kill a sheep if they are not eradicated.

Maggots.

And now—Maggots, one of the biggest curses of sheep farming. As far as I know, the blow fly always lays her eggs on dead flesh, except in the case of sheep where the eggs are laid on the living animal. Whatever may be the reason for this, the fact remains that it causes the shepherds a great deal of work in this country during the summer months. The eggs are generally deposited in the wool on or around a sheep's tail or on her shoulders. And the period of the year when this takes place is roughly between mid-May and the end of October. There are several things one can do to prevent or at least deter the blow fly from laying her eggs on the live sheep. The first and best deterrent is that of clipping the wool short round the hindquarters and thus preventing an accumulation of dirt and stale dung on those parts. In spite of all precautions, some sheep do become infested with maggots. How will Ned know this? If he stands watching his flock for a few minutes, he will see any afflicted sheep constantly turning its head and trying to bite the affected part. In any case the wool where the maggots are will appear to be wet. He catches the sheep, clips off the wool from the affected region and pours on a special liquid which will kill the maggots and will later heal the wounds that have been made in the flesh.

Controversial.

Ned's are Romney Marsh sheep in the south of England, and in their management a number of practices are different from those with some other breeds. For instance, the lambs are shorn when they are about two months old. It certainly is controversial whether this shearing is warranted. You only get about one pound of wool from each of them, in fact not enough, as a rule, to pay the cost of shearing. On the other hand, some folk maintain that the lambs thrive better for being shorn. Well—whether that is correct or not, one thing is certain. The lambs are much less likely to be attacked by maggots after being shorn; the reason being that the blow fly prefers long wool in which to lay her eggs.

Thus, about the middle of May, Ned sets about shearing his lambs, which are now some two months old. Each lamb is then branded with paint to show the farm to which it belongs.

On this farm, yet another medicinal treatment is given to the lambs. Let Ned explain it.

"Well, you know, the governor is what you might call a fairish hand with sheep; but every now and then he hits on something really good. For years we used to find some of our best lambs dead in the field when they were about two months old. We always thought it was caused by their swallowing wool and blocking up their stomachs. A few years ago, we had a post-mortem on three of them and we were told it was due to a trouble called *Pulpy Kidney Disease.*

Serum.

The governor got some serum and we injected all the lambs, with a hypodermic needle. My word! You should have seen the difference. No further deaths and, more than that, the whole lot of them seemed to thrive much better after the injection. At any rate, we do it every year now, generally at the beginning of May and we certainly are turning out much better lambs."

Lamb shearing is finished. It is warm weather and the fly is getting busy amongst the ewes. It is time to shear them. Ned is a good hand at shearing. It will be a joy to watch an artist—for he *is* an artist—at work. On some farms the sheep are washed in a stream or specially constructed bath before the shearing. This is not so much for the purpose of making the wool clean as to wash out its natural grease. But if they are washed, the wool should be shorn off within the next twenty-one days or more grease will go into the wool from the sheep's body and your washing will have been in vain.

Ned will give us a few hints on shearing before he starts.

Shearing.

"I use a machine here. But the idea is just the same as in hand-shearing. On some farms they use a special bench and tie the sheep's legs. I don't. My way of doing it, is to sit a sheep on its rump, keep its head resting against my groin and start shearing along its jaw bone. I work down to its breast and then shear off all the wool on its belly; then back to its head and round the back of its neck; so on down its body from head to tail. One or two 'dont's.' Never lay a sheep on its back when you are shearing and never hold a sheep tightly. If it struggles and kicks it may be that a thorn is caught in the wool and is sticking into it. And always keep her head well up when she is sitting on her rump. If you let the head sag, she will be sure to start struggling. Of course, when you are shearing round the rump or hindquarters you must lay the sheep down, but on her *side*, remember. Just put your foot across her neck and your ankle will hold her down quite securely."

Ned must not begin shearing if the wool is at all wet either from dew or rain, it would soon turn musty when rolled into a fleece. However, to-day it is fine weather and there was no dew in the early morning. He has to see *all* his sheep for a start and then he comes to the shearing pen. He has about thirty or forty sheep penned up in the paddock in a place that is dry and—as is always a good thing, if possible—in the shade. He is single-handed and has to catch each sheep in the pen, pull her out onto the grass and start shearing.

"Hullo, old girl. Come to have your hair cut again, have you? Keep still and I'll soon finish you."

The Machine.

Ned switches on the machine, an electric one, and shearing has begun. The machine is on exactly the same principle as the clippers at a barber's. The speed at which Ned's hand seems to move, the closeness of the shearing and the snow-white appearance of the skin as the wool comes off have an attraction for everyone, those on the land and laymen alike. Ned knows exactly what to do next and soon the wool is off. The sheep is allowed to get on its feet again, a friendly smack on the rump from Ned and away she goes to find her children who are at first a little scared of this white-looking mother of theirs. The wool is lying on the ground. It is in one piece, held together by its fibrous nature. Ned picks it up, spreads it out lengthwise on the ground, the part of the wool which was next to the sheep's skin underneath. He turns the outside edges of the fleece inwards, and rolls it up into a ball, starting his rolling up from the end which was shorn from the sheep's rump. Thus the part of the fleece on the outside of the ball is the wool which came from the shoulders, the best wool on a sheep. He makes a kind of rope from the wool which grew on the sheep's neck, wraps this round the fleece, tucks the rope end inside and there is the finished article.

Fleeces.

He is shearing big sheep, weighing 140–160 lb. live-weight, he has no assistance in catching his sheep or wrapping up his wool and his master will be perfectly satisfied if he shears six sheep an hour. From sheep of this size the fleeces have from 8 to 10 lb. of wool in each.

When next you see sheep-shearing done, please do not think it easy. Oh, yes—it looks easy enough when the expert is doing it. For downright hard work there are not many jobs on the farm to equal it.

The fleeces are generally loaded onto a wagon standing close to the shearer. The wagon is drawn under cover at night or whenever there is a sign of rain, and the wool is finally packed into large jute bags, technically known as "sheets"; it is then ready for dispatch to the wool factor's warehouse to be graded.

The weather has kept fine, the sheep are now all shorn and branded in paint (usually red or blue) with the owner's mark. On some farms the branding is done with tar, and this admittedly lasts much longer than paint, but wool merchants and manufacturers have the greatest difficulty in getting the tar out, and are constantly protesting to different farmers' organizations against the use of tar; surely one ought to try to please the customer if possible.

Grading of Wool.

There is a form of rough grading of wool done by the shepherd before the wool is packed in sheets. For instance, the very dirty wool from

SHEEP SHEARING

around the sheep's tail is cut off and kept separate. This is colloquially called "deggings." Loose pieces of wool lying on the ground or clipped from the sheep at different times are in another sheet. And lamb's wool, which is much too short to wrap into fleeces, is also kept separate.

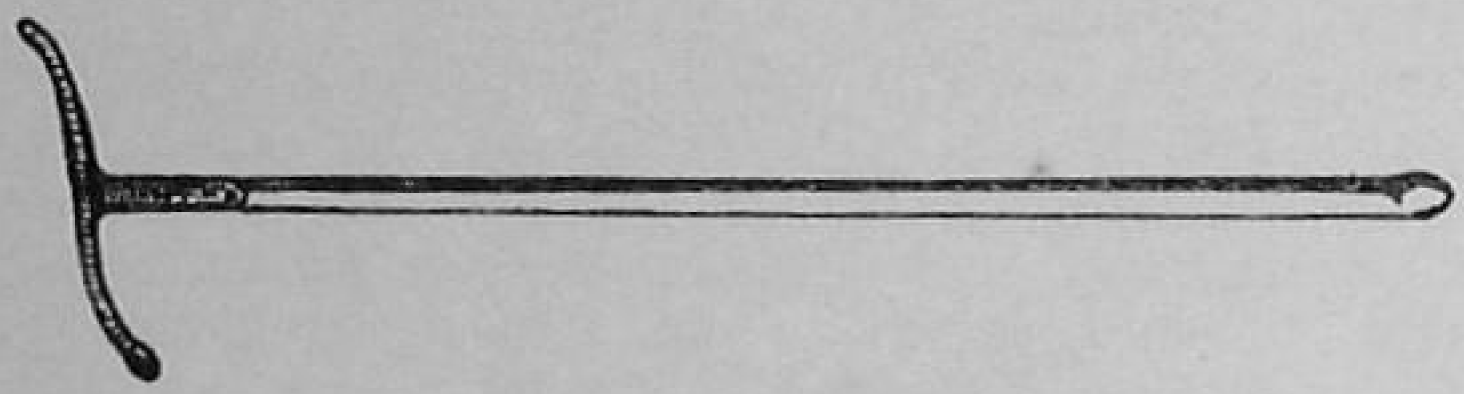
Foot-Rot.

We have not yet made any mention of another curse of sheep farming, foot-rot. A sheep's foot is cloven. The two claws of the foot are made of hard horny material,

whilst the top of the cleft between the two claws is simply soft skin and ordinary flesh. It is in this cleft that the bulk of the trouble lies.

One of the principal causes of foot-rot is that when sheep are grazed on grass which is more than three inches long, as the sheep walks through the field, the long strands of grass are dragged through the cleft in the foot. The tender parts soon become bruised and inflamed and the foot-rot germ, which seems to thrive on all sheep pastures, enters the abrasion. In a very short time the flesh (muscle) inside one or both claws goes completely rotten, causing such agony to the sheep that it soon has the greatest difficulty in walking about. Foot-rot does not kill a sheep, but the continual pain and the difficulty of moving about in search of food will soon reduce a fat sheep to a mere skeleton.

Ned Trumper is constantly on the look-out for foot-rot. It occurs all the year round and needs instant treatment. At the very first sign of a limp he catches the sheep, turns it up on its rump as in shearing and feels each foot in turn with his hand. The foot affected with foot-rot will feel hot, a normal foot is quite cool. Ned takes out his knife, a really sharp one, and cuts away the hoof covering the diseased part. Now,



THE DIPPING POLE

this really is a specialist's job. Too deep a cut and he will go into the fleshy part under the hoof (which is about ¼ inch thick), yet he must expose the whole of the diseased portion under the hoof.

Ned is an expert and has finished this. He next paints the diseased part with a special lotion which will cure the trouble. There is wide divergence of opinion as to the best lotion. There are a number of proprietary mixtures on the market and a great number of home-made cures.

Ned says, " I've tried lots of cures, and the best I've struck is a mixture of butter of antimony and glycerine which I paint onto the foot with a quill feather. I catch the sheep again three days later and paint it again. If I've pared the hoof properly at the first dressing, the sheep will not need a third painting, and a new hoof soon begins to grow."

Prevention.

Like any other intelligent person, Ned believes in prevention wherever possible. Firstly, the number of sheep per acre should provide sufficient mouths to eat the grass as quickly as it grows, and so as to prevent the growth of long strands of grass. Secondly, he uses what is known as a foot-bath. This is a long trough, usually made of galvanized iron, about a foot wide and six inches deep. The trough has railings built close to it on each side and Ned fills it with a solution of copper sulphate in water. He makes a large pen or enclosure at one end of the trough. He puts all his sheep into this pen and makes them walk through the foot-bath. The operation is really quite simple; all he has to do is to force two or three sheep through the bath, after which they are once again free to roam all over the field. The rest of the sheep can see this and it is not long before the whole flock are struggling to get through the foot-bath to freedom without any prompting. This precaution is taken every six or eight weeks, and the copper sulphate solution seems to kill a large proportion of foot-rot germs and most certainly reduces cases of this disease to a great extent.

Ordinary routine work such as has been described goes on with the sheep constantly—the daily inspection or " lookering " as it is known in south-eastern England, the constant battle against maggots, intestinal worms, foot-rot and the less common ailments of sheep.

Sheep Scab.

Here we are at the beginning of July, rather an important time in sheep farming. Years ago the flocks of sheep in this country were very badly infested with a disease known as sheep scab. It is not very prevalent now. A great number of shepherds, including Ned, have never even seen it. But years ago the Government introduced laws making precautionary measures against the disease compulsory and these laws are still enforced. Legislation has in this case almost eradicated the trouble.

Briefly, sheep-scab is caused by a small mite which get on to the sheep. The precaution against it is to immerse the sheep in a liquid, a large proportion of which is arsenic. The arsenic kills the mite but not its eggs, consequently a second immersion has to be made within fourteen days of the first one to dispose of the mites which will have hatched out from eggs in the interval. These two immersions technically constitute what is known as " double dipping." They must take place in any fortnight during July and August, and the police must be advised before it is done. The local constable often comes round on the appointed day to see that the job is done according to law.

On most modern sheep farms, a special bath, known as a " dipping tank " is sunk into the ground and the sheep are dropped into it, kept there for about a minute, and then allowed to climb out of the bath, which slopes at an angle of about 45° at one end.

Dipping day is here. Ned has filled up the " tank " with cold, clean water and has then added the necessary chemicals. The usual turmoil which always accompanies the driving

of ewes and lambs into a pen, is upon him and his assistants. The weather is fine and operations begin.

Ned stands on the edge of the "tank" with a "dipping pole" in his hands; there is an illustration of it above.

The Tank.

One of the helpers catches a sheep, drags it up to the end of the "tank," turns it round so that it faces away from the bath and pushes it backwards. The hind legs of the sheep drop into the tank and the rest of its body follows. The animal is now afloat in the liquid. Ned puts the end of his dipping pole on the shoulders of the sheep, presses down and forces the animal right underneath, head and all. He does not allow the head to remain under the liquid for more than a second. We do not forget that it is poison and he must not let a sheep swallow any of it.

The "tank" holds three sheep at a time. Ned places his pole across the exit end and makes the sheep remain in the liquid for about a minute, then takes his pole away and out come the victims, delighted to get away from it all.

With two men to catch the sheep and put them into the "tank," Ned can with ease dip 100 sheep an hour.

Some of the older sheep have been through this business the year before. They have not forgotten their unpleasant immersion. They are up to all sorts of dodges, including attempts to jump out of the pen, to try and avoid a repetition; after all, it is not a very pleasant experience for them.

Not a very skilled job this, you imagine. Mr. Bishop and Ned think it is. A sheep put into the "tank" the wrong way, any mistake which might cause it to swallow this liquid or a too lengthy immersion, and you would soon have some poisoned sheep.

All is over at last. "Your turn now, Kruger," says Ned. But Kruger was not born yesterday; he has been caught napping during sheep dipping before and like the wise dog he is, he has quietly disappeared.

Lamb Sales.

The great day of the year for a shepherd is drawing near, the day when the lambs are to be sold.

Ned lives in a big sheep-breeding district. At the opening sales of lambs, generally about the beginning of August, about 12,000 lambs are sold each day. Buyers come from as far afield as 150 miles.

The day for the big event arrives; as soon as it is light, Ned brings his whole flock, ewes and lambs, into the sorting pen; other men on the farm turn up to help him. They have to catch all the lambs by hand and put them into a separate pen.

At 5-30 a.m. a large double-decker lorry arrives, and immediately the driver backs up to the lamb-pen he lets down his tail boards. Ned covers the bottom of the lorry with clean straw and the job of loading begins.

Naturally the lambs do not walk up the tail-board on request. Oh, no—nothing as easy as that. You could not drive them in if you tried.

Ned, however, knows how to do it, and he makes it look as simple as can be. He just catches two lambs, drags them into the lorry by force, his helpers push a few more in and Kruger, at the back of the flock, urges them all closer to the lorry. Soon some of the more venturesome decide to walk in to the lorry to see what their pals are doing up there. After that it is easy. A procession begins and then a rush. Ned can now come out of the lorry, his trick has succeeded as it nearly always will.

Away goes the lorry to the fair, where pens have already been reserved for Mr. Bishop's sheep. About three trips, all told, will be enough to transport the lambs from farm to fair. Ned and Kruger travel into market with the last load.

The lambs are penned up in batches of fifty, but as these have been shut up just as they came out of the lorry, there is more work to do and specialized work at that.

Grading.

The best fifty lambs must be put into the first pen, the next best in the second, and so on. Mr. Bishop himself always has the final say in this grading. It is a matter of pride with him that when the lambs are sold in lots of fifty, the prices realized show that the grading of the sheep has been done correctly. That is to say, the best lot makes the most money per head, the second lot the next highest price, and so on down the scale.

Ned, of course, has brought his shears with him. He looks round all his charges once more. There is one which has soiled its wool this morning. A first-class shepherd would never let one of his sheep go in to the auction-ring like that. Out come the shears, the dirty wool is cut away and at last Ned is satisfied.

He bolts his breakfast and immediately goes round the market to see the other lambs. "Are those better than mine?" We shall soon know when they are sold.

Kruger is having the time of his life. His own sheep are finished and done with. Someone over there needs a hand. Off goes Kruger as happy as a sand boy, giving help with their sheep to all and sundry.

The Top Price.

This is Ned's day, too, to-day. His best pen of lambs have made the top price of the fair. A year of hard work, of patience, of disappointment at times, but, whatever else, of skill and devotion to his job, has been crowned by success, just the little extra that, to which no one else has attained!

His fellow shepherds are all determined to beat him next year, perhaps they will; *but he has the laurels to-day.* Once home again that afternoon, Ned has a good square meal and then goes off to look at his ewes once more before the evening closes in; for the last week or two they have obviously been taking less and less interest in their children, but now the lambs have gone the full maternal instinct has come back. The noise of bleating as the ewes call for their children is nearly deafening. How fortunate that Ned has put them in a field a long way from home; we should have been kept awake all night if he had not. However, in about a couple of days the lambs will be forgotten and everything will be peaceful once more.

Routine Work.

Routine work begins again; daily " lookering," foot-rot dressing, drenching and so on. In the middle of August each ewe is examined carefully by the governor and Ned. Those with loose teeth, those with missing teeth, those whose udders are no longer perfect and those with any other physical blemish are not fit to breed from again, and are taken out of the flock to be fattened up for mutton.

Towards the middle of October, the rams must be turned with the ewes if we want our lambs born at the beginning of March. Ned trims off the wool around the tail and rump of each sheep to make sure that no wool shall interfere with the ram's service. Then the whole flock with the rams is turned on to the best pasture on the farm.

Ned's job in winter with the sheep on grass is much less arduous than in summer, very largely because there are no blow flies to lay their eggs in the wool. And so we come once more to another lambing season.

. . . .

" Some roast lamb, green peas, and new potatoes, please, waiter."

Have you ever thought how that lamb got to your plate?

THE PIGMAN

This section begins with one advertisement and ends with another; they illustrate the progress of Henry Philips, who comes as a young man to Mr. Bishop's farm in 1937 and leaves it as a skilled and accomplished pigman to take up the managership of a pig-farm in 1949. The lay-out of the piggeries at Hardwell Grange is indicated. The routine of pig-keeping on a general farm is thoroughly examined and there are notes on feeding and rationing, cleaning of the sties, bringing on young pigs, the weighing of fattening pigs, castration and mating. Some of the difficulties that beset the pig-keeper are mentioned, including swine-erysipelas and intestinal worms and the method of " drenching " a pig is thoroughly explained. Use of pig-ring is to prevent rooting and consequent damage; the way to insert it is described.

SITUATIONS VACANT.

"WANTED.—Single man to feed pigs and do general farm work. Lodgings near. Apply Bishop, Hardwell Grange, Biggenden." —*Pickhill Gazette*, 4th June, 1937.

Boy Will be Man.

HENRY PHILIPS is only 18, perhaps a little young to apply for a job *as a man*. Still, there is no harm in trying, and Henry certainly wants to get hold of a responsible job on a farm. He goes round to see Mr. Bishop. The latter meets him, asks his name and age and says, " I have rather an important appointment now, but I can have a talk with you in half an hour's time. In that shed over there are our pigs. Will you go across and have a look at them and I will join you as soon as I can."

In due course, Mr. Bishop goes across to the pig-house where about 100 pigs of different sizes and ages are kept. He finds Henry in one of the sties bending over a sow which has a litter of eight little ones. Henry is gently rubbing the sow's belly. She is lying on her side, the little ones playing about round her head. You can see from her expression and hear from her grunts that she loves being handled like this. This is not a bad start from a man applying for the responsible job of being in charge of a herd of pigs. Mr. Bishop is quite impressed.

Henry hasn't much knowledge of the feeding and care of pigs, but that can be taught. The main thing is that he is obviously fond of them and can make them fond of him.

The New Pigman.

The usual terms are finally agreed upon and Mr. Bishop says, " Very well, Henry. Report here at 6 a.m. on Monday and I will show you how to feed and look after these pigs."

It is very dark at 6 o'clock the following Monday morning. Henry is already at the pig-house and follows his new master into it.

" Now, Henry. The very first job of all. Look at all the pigs. Switch that light on and come round with me."

The house is of the usual type. A wide alley right down the middle with small pens or sties on each side of it. Each sty holds six or seven pigs and there are a few rather larger pens specially reserved for the breeding sows. Jerry, the boar pig, is kept in another shed away from the herd.

As soon as the light goes on, the pigs wake up and immediately start clamouring for breakfast. The row is deafening. However, Henry and Mr. Bishop walk down the alley and look into each sty. It will take Henry several weeks before he can spot an ailing pig at a glance, but we all have to start as novices. There is a casualty here! One of the sows with litters has unfortunately lain on the top of one of her children during the night.

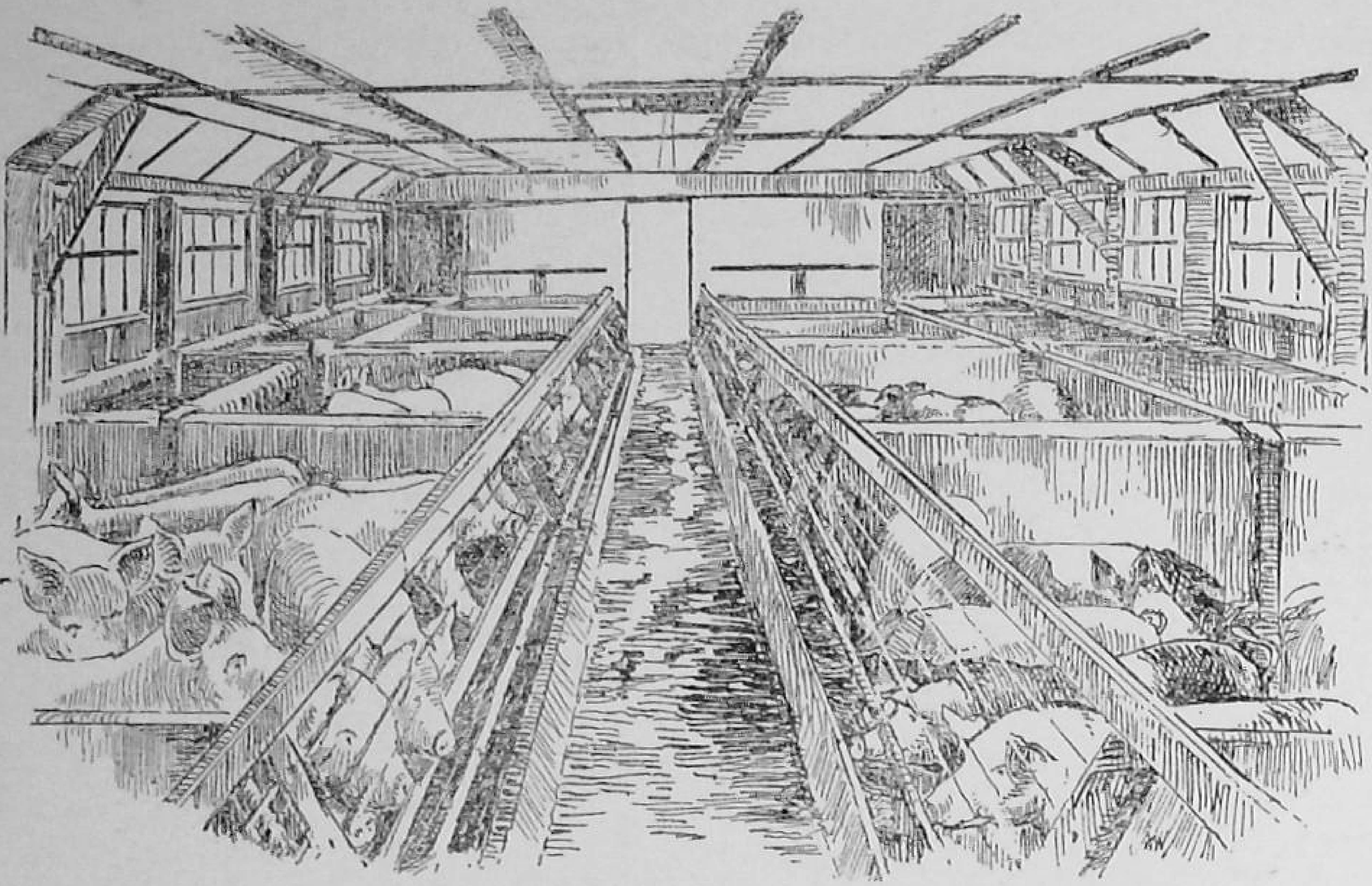
" Do you see that, Henry? " *shouts* Mr. Bishop in the effort to drown the din coming from the whole herd of pigs. " We must get the dead one out at once or the mother may start eating it for breakfast herself; gently does it. Talk to the old sow as you go into the sty, quietly pick up the dead one and carry it out."

Feeding.

The rest of the herd are all right. Now for the feeding. Henry and the governor go to the meal-house—a special room built on to the end of the shed—where the pigs' food is kept. The pig-food, composed of various cereals ground into meal, is in bags weighing one hundred weight each. There is also a large tank on wheels which can be pushed along the alley in the shed. In this tank is the pig meal mixed with water.

Carefully Rationed.

Listen to Mr. Bishop talking to Henry. " On this farm, the pigs are carefully rationed, and for to-day's feed you will need 2 cwt. of meal for their breakfast and another 2 cwt. for the after-noon feed *for the whole herd*. There is a small blackboard fastened to the door of each sty and on it is written, in chalk, the amount of meal required in that sty for each feed. We shall put 2 cwt. of meal into this tank and add water to it until the mixture is fairly sloppy. Then we push the tank into the shed and stop at the first two sties, one on each side. Before putting any food into the troughs which are in each sty, make sure that these troughs are quite clean. If not, you must clean them out with your hands. Now take this measuring bowl—it holds exactly 4 lb. when it is full—and measure out, into a bucket the required amount. The pigs will make a rush at you as soon as you go into the sty with



THE PIG HOUSE

their food. They may nearly knock you down. Whatever you do, don't lose patience with them or hit them, they are greedy animals by nature and can't help this ravenous hunger. Push them out of your way and distribute the food along the *whole* length of the trough. Whatever you do, don't put the food into one half of the trough only. If you do this, it will result in the stronger pigs monopolizing the feeding space and there will be no room for the weaker ones, and they, of course, will get no breakfast. Then stand back for a few seconds, notice either if any pig has not come up for its food or if a weaker pig is being crowded out by the others. If either of these things happen, come and tell me."

Henry at once gets hold of the idea and soon realizes that a pig with a hearty appetite has not, as a rule, much wrong with it. He is now in charge of 100 pigs and can feed them in less than half an hour.

The morning feed has now been served out, and some further instructions from Mr. Bishop follow. "There is a second trough in each sty. That is for the drinking water. Any stale water must be tipped out and fresh put in at each feeding time. When that job has been finished, we shall go off to breakfast."

After breakfast Henry receives instructions about cleaning out the sties. But before doing this, he must look into each sty.

Difficult to Feed.

"Two reasons for this," says Mr. Bishop. "By far the most important of which is to see that all the feeding troughs are empty. By this, I don't only mean empty, I mean that they must have been licked absolutely clean on the inside by the pigs. If you see any food whatsoever, even a smear on the inside of the trough half an hour after feeding time, you will know at once that those pigs are being over-fed. They cannot possibly thrive. Secondly, you must notice whether all the pigs are lying down asleep. They should show no signs of uneasiness; if they do, they are not getting enough food. With the exception of the horse, the pig is the most difficult animal on a farm to feed successfully. I shall tell you each week how much food to give to the pigs, it will be your duty to carry that out exactly, and it is a much more intricate job than it sounds: and now for cleanliness!"

Henry brings a large wheel barrow into the shed and starts on the cleaning out. If given a fair chance, the pig is of course very clean in its habits. It will always make its dung in one corner of the sty, it never soils its bed or the corner where the feeding trough is placed. Into the wheelbarrow Henry shovels out the dung and sweeps clean the corner of the sty where it was. He keeps up a running conversation with the pigs whilst he works. In a few days' time they will be chewing gently at his boots and rubbing up against his legs when he is cleaning them out. This mutual affection is worth far more than can be described. Apart from anything else, how interesting it makes the job!

When the barrow is full he wheels it out of the shed, puts the dung onto the heap outside the shed, and goes back for the next load. In about three-quarters of an hour the cleaning is finished.

Henry then puts some fresh clean straw into each pig pen and goes to the sties containing the sows and litters.

Little Pigs.

"In these four sties, Henry, the little pigs are more than four weeks old. At that age they will begin to eat a little food themselves. You will notice that one corner of the sty is fenced off and that there is a small entrance through the fence, big enough to let the little pigs through, but too small for the sow. In that corner is another small trough. I want you to put a small amount of food in that trough. The little ones will be able to get at it but the mother cannot. The youngsters will keep nibbling at it all day long and you must, of course, take out of the trough in the evening all the food that they have not eaten during the day.

"The mothers of the older pigs are turned out into a small paddock every morning to get exercise and a bite of green grass. It is no use turning out the sows with very young litters, the mothers will not leave their offspring as young as that, even for half an hour.

"No more to do here this morning, Henry. Bury that little dead pig and then go down to help with the potato sorting. After dinner, bring the sows back from the paddock to their litters and carry on with your job at the potatoes. Come back about 4 p.m. and give these pigs their afternoon feed. It's exactly the same as the morning routine, but we don't clean the sties out in the evening. Once a day is enough. I shall be too busy to help you this afternoon, can you manage alone?"

"Yes, sir, I'm sure I can," says Henry, delighted at the idea of being solely in charge.

Solely in Charge.

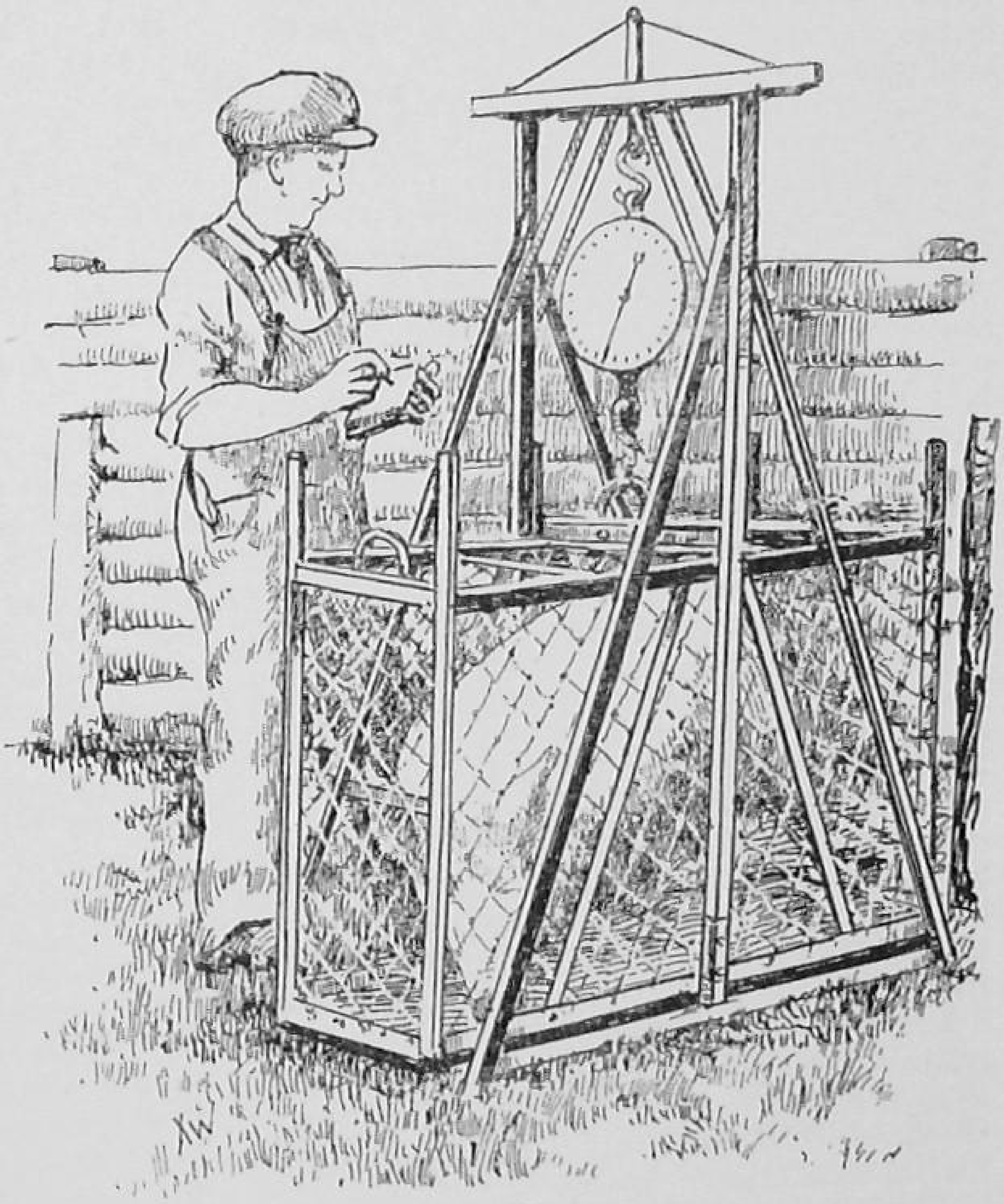
"Very well. But come for me at once if you have the least doubt about anything. Don't forget that you are still quite a novice about pigs. It is these small details that really count at this job," says Mr. Bishop.

Henry is settling down splendidly. The governor believes that he has the makings of a first-class pigman and gives him every encouragement.

Pigs are Weighed.

Thursday is the most interesting day of the week. On that day, all the fattening pigs are weighed, but not the sows and litters. Mr. Bishop himself always gives a hand with this. After the sties have been cleaned out, the portable pig-weigh is wheeled into the pig-house. It is a kind of wire cage which admits one pig at a time (see drawing). A spring balance on the top of it show the weight.

Henry wheels the pig-weight up to a sty, opens the cage door and the sty door and everything is ready. The pigs are very tame and, after being weighed twice, with an interval of a week between the weighings, there is no difficulty in getting them into the cage. There has to be a certain amount of coaxing to begin with, a pig is the most difficult of all animals if ever he makes his mind up not to do something; then he is definitely "agin the government" every time.



PIG WEIGHING

Mr. Bishop writes down the weight of each animal in the pig-book. When one batch is finished he adds up, finds the total and compares it with the weight last week.

"These seven pigs weigh 492 lb., Henry. They weighed 460 lb. last week. An increase of 32 lb. And they have eaten 150 lb. of meal in the week. It has taken about 5 lb. of meal to add every 1 lb. of weight. Nothing very startling in that. From what I've seen of you, I'm sure you will improve

on it. Your target must be 1 lb. increase of weight to every 4 lb. of meal. Once again, concentrate on the small details I've explained to you."

Rationing.

The weighing is finished. The rationing is quite simple. In round numbers, the amount of dry meal fed per day is one pound to every 20 lb. in weight of the pig. A little division sum, another of multiplication and the daily ration for each sty is worked out. This is written up in chalk on the little blackboard nailed to the sty door and Henry knows at a glance exactly what to feed to each batch of pigs and, what is more, knows exactly how much food per day the whole herd requires.

This is also the day for mixing up the different kinds of meal that go to make the pigs' food. Enough is mixed up to last a week. Mr. Bishop gives Henry the list of the ingredients and the correct proportions of each. Henry puts all these ingredients into a heap on the floor and shovels it over several times to make sure that it is evenly mixed; he puts the complete mixture back into the empty sacks which each contain a hundredweight when full.

Castration.

About a fortnight later, Mr. Bishop comes to see Henry during a morning feed. "After breakfast the young boar pigs in those two litters at the bottom of the shed must be castrated. They are just six weeks old and that is the ideal age. I shall show you how to do it," he says. "It is a job that all first-class pigmen should be able to do themselves."

First of all, the sows must be turned out into the paddock unless Henry and the governor want to be savaged, as they would be if they started operations when mother was present. Then Henry catches the first young boar. He grips it firmly with both hands, by the hind legs. The piglet is screaming at the top of its voice, but we cannot help that. It certainly is not hurt yet. Henry holds the pig, head downwards, between his legs, the belly of the pig to his rear. Then he closes his knees, not too tightly, on the pig's shoulders; and now the animal is fast.

As everyone knows, the scrotum and testicles of a pig are just below the anus. Mr. Bishop has a very sharp knife in one hand. With thumb and forefinger of the other he squeezes one testicle close up to the skin of the scrotum. Then he makes a slit about 2 inches long in the skin. The pressure of his thumb and forefinger forces the testicle out of the scrotum through the incision. He then moves his hand and gets hold of the testicle which is still attached to the body by two fleshy cords. Great care is needed here. He must not pull that testicle at all, or he will permanently injure the pig. He simply holds it fairly gently, a quick snip through the cords and all is over. The same with the other testicle. Henry then carefully lowers the pig to the ground and its troubles are over. The expert can do the whole job in thirty seconds.

This operation, technically called "cutting" a boar, is a great deal less painful than it may sound. The pig hardly bleeds at all and within half an hour, in the vast majority of cases, he will be contentedly sucking his mother who is generally brought back to her littler as soon as castration has been finished.

Occasionally, a little boar pig has either been born ruptured or has ruptured himself shortly after birth. Part of his intestines have come down into the scrotum. Such pigs are colloquially termed "brokes." Mr. Bishop never castrates a "broke." If he did, he would have to sew the wound up afterwards to keep the intestines inside. A "broke" must, of course, be kept away from females when he gets older or he would mate with them. The flesh of an uncastrated pig is a good deal inferior in quality to that of the castrated one.

The First Golden Rule.

Henry is doing very well at his job after the first difficult month. His target has not yet been reached, but it shows improvement every week. He has learnt that although the rationing system is the best way to feed pigs, you cannot quite run "according to the book." For some unaccountable reason a batch of pigs suddenly goes off its feed. He remembers the first golden rule, "A pig should lick its own trough out absolutely clean." Here are pigs leaving their food. There is no need to tell him, now, that he must take that surplus food away from them after half an hour and must reduce their rations in their next feed, regardless of what the book says they ought to have. In most cases they will have regained their appetites after a couple of days.

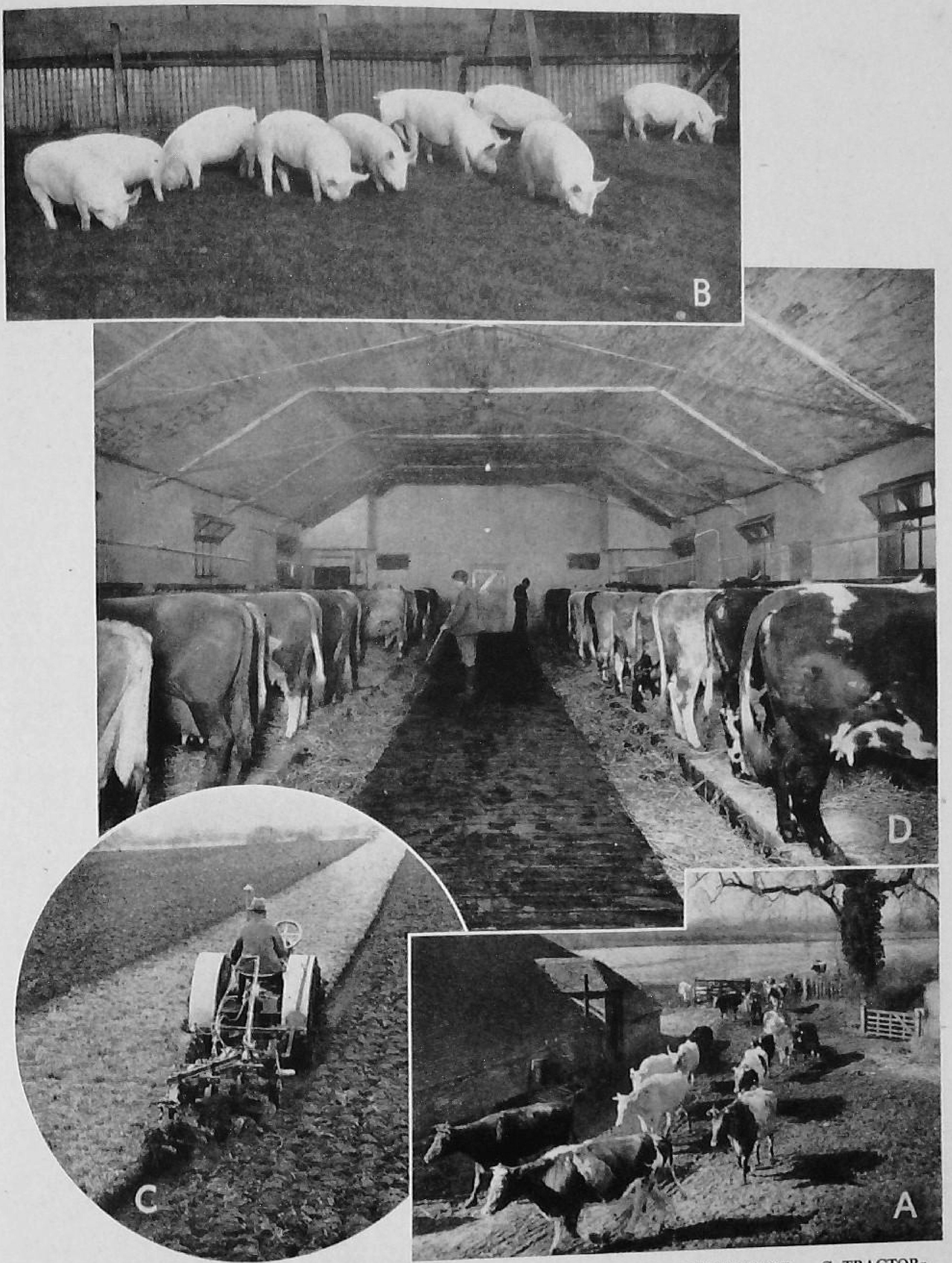
The breeding sows are not fed in accordance with their weight. The amount of food is regulated according to the number of little ones they have. But the same rule applies of giving them the quantity of food which they can really clean up in less than half an hour. When the little pigs are eight weeks old they are weaned from the mother and put into a sty, on their own, to be fattened.

Provided that the sow has proved a satisfactory mother and has reared a good healthy litter, she will be used for breeding again. From weaning she is put straight into the sty where Jerry, the boar, reigns supreme.

From four days to a week later, she will come on heat colloquially known either as "brimming" (north country expression that) or "hogging."

Mating.

Henry may not actually see the mating take place, but it is quite easy for him to know it has happened by the scratches made on the sow's



GOOD FARM WORKMANSHIP: A. IN COME THE COWS. B. PIGS: THEY CHURN UP THE SOIL. C. TRACTOR-DRIVING: THE EXPERT AT WORK. D. BEDDING-UP FOR THE NIGHT.

Farmer & Stock-breeder Photographs.

Above: HEALTHY AND PROMISING YOUNG STOCK

Farmer & Stock-breeder Photo. Courtesy: Nackington Farms, Canterbury.

Below: SHIRE GELDINGS AT CREWE

Farmer & Stock-breeder Photo.

flanks by the boar's forefeet when he has mounted her, and by the swollen appearance of her generative organs. He writes the date down in the pig-book and provided that the sow is pregnant from this mating, she will farrow in sixteen weeks' time. If she is not pregnant, she will come on " brimming " again in three weeks' time, and must be turned with Jerry again. The expert pigman can tell when a sow is " brimming" when she is not with a boar, by her uneasy behaviour, by the redness of her generative organs and by a sticky fluid coming out of the passage.

During his first two months at the job, Henry has had plain sailing. Then trouble begins. And, strangely enough, trouble with live-stock nearly always comes thick and fast, not in isolated cases.

Something Wrong.

One morning Mr. Bishop is in the cow-house, where, as it happens, more than the usual number of difficulties is being encountered. In walks Henry who has not yet seen the governor on this particular morning. " Hello, Henry, something wrong by the look of your face: what is it? " asks Mr. Bishop.

" There is one pig out of that lot in sty number 9 which looks to be dying. It can't get up and there are great purple patches all over its skin. And those nine little pigs we weaned last week are doing very badly, and some of them have a terrible cough this morning; sounds like tuberculosis to me."

" Very well, Henry. We are in the middle of straightening out some trouble with these cows but I'll be along in a quarter of an hour. In the meantime, carry on with feeding all the other pigs until I come." Then, turning to the cowman, the governor remarks: " It never rains but it pours. The shepherd and the waggoner are sure to have something wrong with *their* animals this morning, just to make a real day of it."

No fluster, no bustle—a farmer must keep calm when troubles crop up. And now to the pig-house.

" Ah, yes, Henry, rather what I expected from what you told me. I feel pretty certain that your dying pig, and it is dying all right, has got swine erysipelas. There is just a chance that it may be swine fever, a much more serious disease, so we'll call in the veterinary surgeon to find out for certain. You have an empty sty over there. Put these other pigs into it. I mean these that have been in the same sty as the sick pig. Now, what about your little pigs? "

This litter really is a miserable looking one. Their bellies are tucked up like those of greyhounds. Their skins are very grimy-looking, not pink and clean like those of healthy pigs and each time they cough it seems to rack the whole of their little bodies. Yet they eat very well, in fact they seem to be always hungry. Mr. Bishop casts an expert eye on them.

Intestinal Worms.

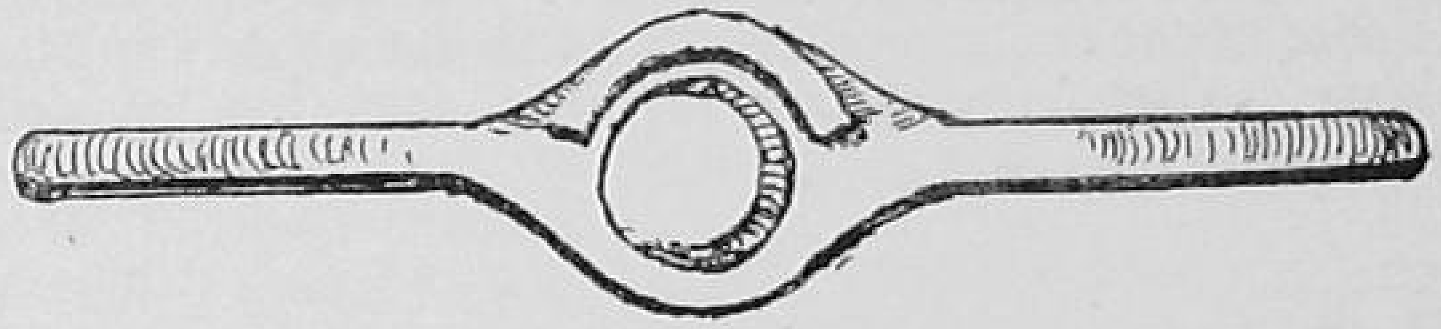
" I don't think there is anything very serious here, Henry. In fact, I'm sure the trouble is caused by intestinal worms. We can handle that ourselves without veterinary assistance. Don't feed them this morning. After breakfast we will give them something to clear the worms out of the system." As with all animals, this giving of medicine to pigs is called " drenching " in farming circles.

The veterinary surgeon arrives. The sick pig has already died, but the diagnosis confirms the governor's suspicion of erysipelas. The dead pig is buried, the sty thoroughly scrubbed out and disinfected, whilst the contact pigs are put on to a very laxative diet for two or three days.

At last there is time to tackle the little pigs. Mr. Bishop uses a medicine containing oil of chenopodium as antidote to worms in pigs. And this is how he " drenches " them.

Henry holds the pig between his legs and inserts a gag into its mouth. Here is an illustration of the gag.

He grips the gag by each handle, forces it back



Pig Gag.

into the pig's mouth, and at the same time forcing the pig's head upwards. He can easily hold a little pig between his legs at the same time, but would need extra help to keep a larger pig fast. Mr. Bishop pours the required dose very steadily into the pig's mouth. The liquid passes through the hole in the middle of the gag and down the pig's throat and the job is finished. In four or five days the pigs will be drenched again and that will be the end of the worms. Henry is so impressed by the improvement in these pigs after " drenching " that he is apt to spend more time than he ought leaning over the sty door and looking at them. However, Mr. Bishop is an understanding man, he turns a blind eye on a small item of this sort.

Disillusioned.

Mr. Bishop comes in to breakfast one fine summer morning with the consciousness that everything on the farm is all right for that day at least. He is soon disillusioned.

" Have you looked in the paddock lately where the sows are, dear? " asks Mrs. Bishop.

" No—cannot say I have," says her husband.

" Well—will you go round that way after breakfast, please, and then you will understand what I'm talking about," replies Mrs. Bishop.

Now the paddock adjoins the flower garden, Mrs. Bishop's special preserve, and is very clearly visible from that place. No wonder she is somewhat upset, one would think that half a dozen tanks had been on manoeuvres there, so churned up is the soil by the rooting of the pigs.

"Very sorry, my dear—entirely my fault—I forgot about having rings put into the pigs' noses, and of course Henry is not yet experienced enough to have reminded me about it. However, we'll soon put that right," says the contrite Mr. Bishop.

The guilty sows are soon rounded up in a sty; Henry and the governor are ready. A pig ring is made of a thin strip of copper or of copper wire. The two ends have been pointed. The ring fits into a special instrument shaped like pincers. The gap in the ring is wide enough to pass over the tip of the pig's nose. The pincers are closed and the sharp points enter the skin, penetrating not more than half an inch. The ring is left in the nose and from that time onwards any pressure on the ring will cause the sharp points to prick; hence there is a cessation of rooting. Of course the operation is not as easy as all that. The difficulty lies in keeping the pig fast whilst the ringing is carried out.

Henry has a strong piece of cord. He makes a noose at one end and quietly walks up alongside the pig. Then he bends over her head, drops the noose in front of her face till the bottom of the loop is just in front of her mouth; now, by pulling back gently, he gets the cord right inside her mouth and then quickly tightens the noose round the upper jaw. A turn of the loose end of the cord round a convenient post and the pig is securely tied fast by the cord round her upper jaw. She cannot get away.

. . . .

Henry is now a man of 30. He doesn't go rushing for the governor when something is wrong. He can usually handle it himself. His training with Mr. Bishop has borne fruit. This is the sequel:—

SITUATIONS VACANT.

"MANAGER required for pig farm. 2,500 pigs. Must be thoroughly skilled in rationing, breeding and general management of pig herd. Thoroughly competent to supervise assistants. Good salary. First-class house.—R.B., Office 'F. & S.,'" *The Farmer and Stockbreeder*, 10th July, 1949.

Henry applies for this job. Mr. Bishop gives him every support in his application.

The appointment is secured by Henry. He has proved well worthy of it.

THE WAGGONER

Bill Lyon comes of a stock that has handled horses for generations: perhaps there is something in heredity here, for this waggoner is a real expert. First we look at Mr. Bishop's stable and receive some hints on the general management of horses. Feeding is demonstrated, so also is the fitting of the harness before the day's work begins. The plans for ploughing and the actual ploughing itself are described. The principle and work of the balance plough are explained. Feeding and watering after work are governed by important considerations of health, and these receive attention. The horse-pasture is used from spring onwards. Some illnesses are discussed and pitfalls for the unwary are disclosed. Harrowing and drilling are noticed and there are also accounts of making potato-rows and of horse-hoeing. A few final hints and praise for one of the finest animals in creation bring an interesting section to an end.

Most first-class farmers are keen judges of livestock. Mr. Bishop is no exception to the rule, in fact he goes so far as to keep good dogs and cats. But he just has that extra touch with a horse. All his horses are of super quality.

One of the Plums.

The job as waggoner on his farm is considered to be one of the plums of the district. And here is the man that has had that job for nearly twenty years.

Bill Lyon is 45 years old. A huge, broad-shouldered man, he is easily the strongest member of the farm staff. In his youth he did his share as a dismounted cavalryman in the trenches in France and had a good local reputation as an amateur boxer. He is the sort of man one would rather have as an ally than as a foe. Horses are in his blood. His father has recently retired from active work as a farm bailiff, after graduating from a waggoner's position. His ancestors for generations back have been horsemen, so perhaps there is something in heredity.

Well—we are talking about Bill's job now. He has four horses under his charge, four beauties at that, all matched in colour. They are bay coloured Clydesdales, two mares and two geldings.

The Stable.

First of all the stable. A stall for each horse, at the front of each stall is the manger some three feet above the ground level. Higher still, and in one corner of the stall, is the hayrack, the bottom of which is about six feet from the ground. There are stout wooden partitions between the stalls and a brick floor sloping slightly towards the back of each stall. Why brick and why sloping? Brick is warmer to sleep on than concrete and the slope carries away the urine from under the horses.

There are also a corn bin (divided in two), an empty space which can be filled with both straw for bedding and hay for feeding and on the wall behind the stalls pegs upon which the harness is hung.

Small and Often.

The cold winter weather has begun, the horses are sleeping in the stable every night. Let Bill give us some hints on how to look after them. This is what he says: " Horses must of course be kept absolutely clean, and that means a good grooming morning and night. Feeding? The governor always says that a horse is the most difficult animal of all to feed properly, and I know he is right. My recipe is—small feeds and often. You'd better come round to-morrow morning and see what I do."

Bill arrives at the stable just after 5 a.m. The horses have heard him before he opens the door, and there is a sound of whinneying as he goes in.

On goes the light. " How are you all getting on this morning?" asks Bill. " But horses don't understand English," says the amateur. Perhaps not as we do, but they would miss the running commentary that Bill indulges in when he is in the stable. It starts off a friendly feeling for the day. Human beings appreciate that. Why not animals?

Bill looks into all the mangers for a start. There are sure to be some fragments of hay that have been pulled down from the hay rack during the night, and he cleans them out. Should he find any remnants of last night's feed of corn, he knows at once that either he has made a mistake in his feeding or that the horse in question is out of sorts and that he must report this to Mr. Bishop when he appears.

First Feed.

The mangers are now all cleaned out. Bill starts the first feed of the day. It consists of a mixture of chaffed hay (or oat straw) and crushed oats (or bran if the horses are not working hard). The mixture is about half and half by weight. He feeds about 2 lb. of this mixture to each horse and then sets about cleaning out the stable. The dry bedding near the horse's forelegs is pushed under the manger. It will be used again to-night. The soiled bedding where the horse has passed urine or manure is loaded into a wheelbarrow and taken out of the stable. Incidentally, a horse makes " manure " not " dung " according to agricultural parlance.

This job will take Bill about a quarter of an hour. He then gives the horses their drinking water. He draws this into buckets from a tap in the stable and takes the buckets to them in their stalls.

A Complaint.

The horses have now eaten up their first feed, had a drink and are ready for the next feed. Bill gives them the same amount as they had before. But what is this? That big bay gelding, Doctor, seems to be sneezing into his manger rather a lot. Bill knows what the trouble is. That chaffed hay is rather dusty. A good pseudo-sneeze into the manger will blow most of the dust out and leave clean food. Oh, yes—Doctor's got his head screwed on all right, but it will not do for Bill. Horses cannot be expected to thrive on food of that sort. Mr. Bishop is going to receive a complaint when he arrives. Probably the governor is worried to death about the cows, the sheep and the pigs, but he is not worthy of being the governor if he cannot provide better food for horses than this. Of course this error is put right at once.

We are getting ahead of schedule. Bill gives his horses a run over with a strong brush, adds a few words of wisdom which they understand far better than one would think, and goes home to breakfast.

The Collar.

At 6-30 a.m. Bill is back in the stable. Don't forget, he said, " Small feeds and often." The horse now get another feed similar to the previous ones. He knows that they are all going to work to-day, so he puts on their harness. The only difficult part of the harness for a layman is the horse collar (known in north Yorkshire as a " barfun "). It is shaped to fit a horse's neck. When you are going to put it onto the horse, you turn it upside down and you will find that the broad end will slide over the horse's head quite easily. Past his head, you will come to the thin part of his neck. There, you turn the collar round and you will find that it will fit his shoulders exactly. It is essential that a collar should fit a horse exactly. He pulls his load or plough from his shoulders by chains which are hooked on to the hames. The hames, by the way, are two long pieces of metal or wood which are strapped on to the collar and fit into a groove specially made for them on the collar. Thus a small size collar will not slide far enough down the horse's neck and, when the pull of the load begins, will press against the horse's windpipe and choke him, whilst too large a size of collar will cause the pressure to come onto the points of the shoulder blades and this will bruise, and eventually cut, the skin. The experienced horseman can tell at a glance if this particular piece of harness is comfortable for the horse. It really is a most important detail.

Bill's orders this morning are to go and plough a wheat stubble. Mr. Bishop says: " Don't go deeper than 4 or 5 inches, Bill. We shall be sowing oats there next spring. You'd better plough it from north to south: we ploughed it east to west last year and we want to go the opposite way this year." Bill's mate, who has now arrived, receives orders to take the two mares in a wagon for some haulage work.

Bill puts the bridle (or blinkers) on the two geldings, Doctor and Prince. Fixed to the bit of the bridle is a short bearing rein which is hung over the top of one of the hames sticking out above the collar. This rein prevents a horse from getting his head down as far as his knees. There is a little farming etiquette here—the bearing rein is always hung over the right hand hame, never over the left hand one.

Ready to Go.

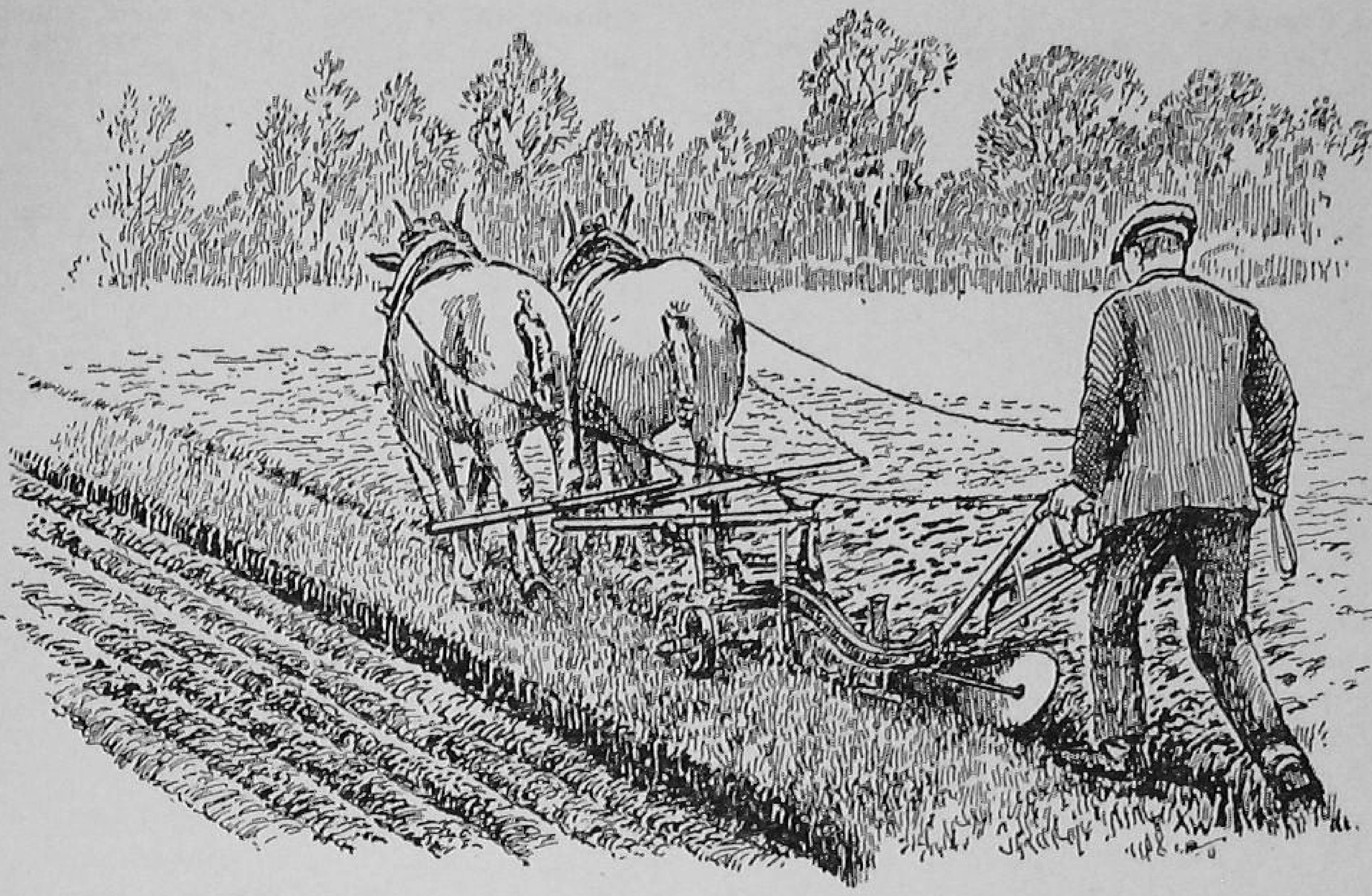
Once outside the stable, Bill ties a piece of cord to the bit in Doctor's mouth, the other end of the cord to Prince's bit and they are ready to go. He jumps on to the left hand horse. " Come on, boys! " and off they go, keeping of course on the right hand side of the road. Another farming habit is noticed here—Bill sits sideways on his horse with his right shoulder to the horse's head; this is much more comfortable than sitting astride when you know how to do it, but not as easy as it looks. Try it some day if you have a chance.

Plans for Ploughing.

Here is the field where Bill left his plough yesterday. He yokes up the horses to it and drives off to the adjoining field where he is to start operations to-day. He ties up the horses to the gate and starts making his plans for ploughing the field. First of all he cuts half a dozen sticks about three feet long from the hedge. Then he fixes a piece of white paper or white cloth to the end of each. Next, carrying his bundle of sticks with him, he walks a distance of 50 or 60 yards down the hedge, and then stops and steps out from the hedge into the field, a distance of exactly 40 paces. At this point he pushes a stick into the ground, a piece of white paper being of course at the top of the stick. He does the same thing another 50 or 60 yards down the hedge and so on till he comes to the end. He now has a row of sticks exactly 40 paces from the hedge and exactly parallel with it. Back he goes to his horses, unties them from the gate and drives them to the end of his row of sticks. Here he turns the horses into the field and manœuvres them in such a way that from his position behind the plough, he can look forward between the two horses and see the row of sticks straight ahead. He has put the white papers on them to make it more easy to see them. A small adjustment to his plough so that it will not go in very deep, no more than about 2 inches, and off he goes.

Off He Goes.

He must keep his eyes fixed on the row of sticks. His hands must rest lightly on the handles of the plough to prevent it from falling over sideways and at the same time he must drive those horses exactly down the line of sticks. When he reaches



HORSE PLOUGHING.

the far side of the field he stops and looks back along the shallow furrow he has made. As straight as a gun barrel, not a sign of wavering to be seen.

Bill pulls his horses round and drives them back across the field along the first furrow he has made. The majority of ploughs in this country throw the soil they cut to the right side of the plough. This time he drives the plough so that the point of the share is running exactly along the line which it made in the first trip across the field. Thus when he has got back to his original starting place he will have left behind him a kind of shallow trench about 2 inches deep and 18 inches wide, the width of course being exactly double the width of a single furrow which the plough normally cuts. On each side of this trench is the soil which the plough has thrown out on its two journeys across the field.

Highly Skilled Work.

Bill turns the horses round once more. The idea now is to plough the soil on each side of the shallow trench back into it, together with some more soil lying underneath this fresh-turned mould. Consequently he drives up the left-hand side of the trench with the share point well underneath the excavated soil. The plough throws it back into the trench and a further 2 inches of untouched soil with it. He does the same with the remaining side and everything is now ready for straightforward ploughing. In Yorkshire the technical term for this operation is " setting out a rig," but each district has its own phrase. In whatever county one may be the fact remains that this is highly skilled work and cannot be carried out successfully by a novice.

After " setting out the rig " it is fairly plain sailing. The horses now have a furrow in which one of them walks, and in consequence the animals need hardly any *driving* at all. Bill adjusts his plough to make it work at the required depth and when that is done it requires very little guidance. He ploughs up one side of the " rig " and down the other, the horses and implement doing practically all the work. At the end of the furrow the horses are turned to the right in readiness for coming down the furrow on the other side of the " rig." The land on which they turn at the furrow ends is known as the " headland " or " fore-acre " and is not ploughed until last. Thus when Bill reaches the " headland " he presses hard on the right handle of the plough and causes the point of the share to come above the ground. He keeps this handle down whilst travelling on the " headland " and does not release it until the plough is in position at the beginning of the furrow.

Obviously the ploughed strip of land becomes wider and wider as he goes on ploughing. When it is 20 yards wide, that is 10 yards on each side of his initial furrow, he " sets out another rig." Again exactly 40 paces from and parallel with his first one. He ploughs this " rig " until it is 20 yards wide. You will now see there are two " rigs " with an unploughed strip of 20 yards between them. He now concentrates on this unploughed strip. Up one side and down the

other, but this time his horses will be turning to the left on the "headland" instead of to the right—as they were when ploughing round the "rig." As a matter of interest the Yorkshire expressions are "ploughing at gee" when your horses turn right on the "headland" and "ploughing at arve" when they turn left. In fact the ploughmen in that county simply say "Gee!" to the horses when they want to turn right and "Arve!" when they want to turn left. Having learnt that little bit of jargon, you will not feel yourself in a foreign country if you happen to hear it in the "county of the broad acres" at some future time.

Last Furrow.

Meanwhile Bill is getting on with his ploughing. There is now only a strip of unploughed land about 2 feet wide, or about as much as the plough can cut in three journeys. He re-adjusts the plough so that it won't go more than 3 inches deep, goes up and down the strip and finds himself left with a width of 8 or 9 inches of land the whole length of the field, still left to plough. Ploughing this last furrow is once again skilled work. He must keep a firm grip of the plough-handles to prevent the implement from swerving. The last time across and the job is done! And very well done, too! This job is universally known as "taking up the furrow."

Ploughing, especially with horses, is one of the most attractive jobs on a farm. No wonder the ploughmen whistle and sing as they follow the animals. In the big arable districts one of the main ambitions of the boys on the farms is to be allowed to take out a pair of horses to plough.

The actual ploughing time which horses work does not amount to much over eight hours per day, and they would have to move fast to turn over much more than ¾ of an acre in that time if the width of the furrow were 9 inches. Naturally they would do more if the furrow were wider, but there would be several complications if the furrow were widened to 11 or 12 inches.

Balance Plough.

There is another kind of ploughing, that performed by what is known as a "balance plough." Briefly the "balance plough" is an implement which is a combination of two ploughs. One with a mould-board on its right side, the other with its mould-board on the left. Only one of these two ploughs can work at a time, the other one being right out of the ground. As the ploughman steers his plough up the furrow the soil is thrown to the right. When he reaches the opposite side of the field, he lifts the plough right out of the ground, and as he does so the other plough comes down to the land. These two ploughs more or less balance each other when one or the other is lifted (hence the name of the implement) and in consequence this work of lifting is not particularly difficult. The plough with the lefthand mould-board is now ready for action. It will be easily seen that the ploughman can drive back down the same furrow which he has just ploughed because the soil he now ploughs will be thrown to the left. A balance plough does away with the necessity of "setting out rigs" and "taking up the furrow." You simply start alongside the hedge on one side of the field and go on ploughing furrow after furrow until the whole area is finished. A disadvantage of the "balance plough" is that the horses have a much heavier implement to pull than the ordinary plough.

So much for ploughing.

Mealtimes.

Horses and man cannot exist on "fresh air and scenery," so we must not forget meal-times.

Bill Lyon brings his horses back to the stable at noon. They are, of course, sweating hard after the morning's hard pulling and, given the chance would probably drink about three gallons of water each, a most dangerous thing for them to do in their heated condition. Bill allows them to have a small drink, a gallon at the outside, and gives them a small feed of crushed oats and chaffed hay (or oat straw), not more than 2 lb. each. Then he puts some hay into their hay racks, about 7 lb. per horse, and goes home to his own dinner. He will be back in the stable in about three-quarters of an hour. There is another small feed of crushed oats and chaffed hay for them as soon as he arrives. Then he pays a visit to the haystack to cut out a truss of hay for them. He keeps away from the stack that furnished the hay that caused Doctor to give his sneezing exhibition in the morning.

"Oh, no!" he says to himself. "That won't do for horses." Bill gets some really choice stuff for them. There is still five minutes to go before one o'clock, and that is just time enough for another small feed, and by now the horses will have cooled down. They can drink as much water as they like now and off they go back to plough at 1 p.m.

Home at Night.

When they return home at night, harness is taken off and hung on the pegs. The same routine as before is observed about food and drink, but now there is a slight addition of work for Bill. He washes the shoulders of each horse with cold water. This tends to harden the skin and to prevent a possibility of soreness.

Tea-time for Bill now. He will be back in the stable about 7 p.m. More small feeds, more water, a grooming down with curry-comb and brush, putting down straw in the stalls for the night's bedding, more hay in the racks. "Good night all." And Bill has finished about 7-45 p.m.

Towards the end of November the hair on the bellies, between the fore and back legs and round the lower parts of the thighs, is clipped

short. This makes the job of cleaning the horses much easier and they seem to thrive better in the winter time if it is done.

The Horse Pasture.

When the grass begins to grow again in the spring, Bill turns the horses out into the horse pasture. How delighted they are to get out. They will gallop round the field, kick their heels in the air for joy, roll over and over on the grass and chase each other for half an hour after first being turned out. The weather is warm. They sleep outside at night now, and of course their principal food is grass, which they can bite off for themselves whenever they feel like it.

Bill never takes any risks of chills and the like with horses, he knows that a horse which has been working hard and is sweating may easily catch cold if turned out in the pasture in its overheated state. Therefore he always leaves his horses in the stable for an hour every night after he has brought them home from work, just long enough to let them cool down.

Care of Horses.

Mr. Bishop will perhaps add a few more words on this subject of the care of horses. "Yes," he says, "small feeds and often is the golden rule. Just enough for a horse to clean up in about ten minutes, then let him wait ten minutes before you give him the next lot. In the end he will eat the two feeds in half an hour all told, but if you lump them together and give them at one time he will never thrive. What happens? He eats for ten minutes, has his ten minutes' pause and starts again. This time he has stale food in front of him, food that he has breathed over and probably sneezed upon. He doesn't fancy it and simply pecks at it. He will leave some of it and of course that has to be thrown away. Sheer waste! Do not give a horse much to drink when he is hot. Keep him well groomed and do not forget to talk to him. It does not matter what you say, but he loves to hear your voice. Under no consideration go up to a horse anywhere without saying something to him as you approach. And lastly, be the master of him. He will spot any sign of weakness in you far quicker than any human being can and he will play on that as hard as he can. Be firm with him at all times and you will have a most loyal and devoted friend."

Ailments.

The care of horses is not always plain sailing. They have their ailments in common with other animals. The most usual complaint is a form of stomach trouble known as "colic" or "gripes." This gives a horse a most violent stomach ache. Unfortunately, horses seem to be less capable of standing internal pain than any other domestic animal. They become exceedingly fractious with "colic" and work themselves up into a very excited state. But let us see what happens one morning when Bill goes into the stable and finds Prince in the throes of this complaint.

The horse is covered with sweat in spite of the weather being cold, he is extremely restless, switching his tail and stamping his fore feet on the ground. Bill takes an empty bucket up to the manger, cleans out any scrap of food that may be left there and removes any hay from the hayrack. This is a most essential preliminary; not that Prince is likely to eat any food when he has colic but when the spasms of pain come on there is just the chance that he may nibble at something if only to take his mind off things, and food at the moment would be very dangerous.

Bill then covers him up with a horse-rug to prevent his catching a chill. "Ah! would you!" chides Bill. "Stand up, Prince old boy." He has just prevented the horse from lying down. Therein is the greatest danger from colic.

A horse seems to get relief from lying down and turning on to his back. Then he twists his body from one side to another, at the same time running a very grave risk of rupturing his bowels. In fact it is probably correct to say that in the great majority of fatalities from colic, death is caused by a horse rupturing itself and not by the colic itself, which is by no means a "killing" complaint.

Help at Hand.

Obviously the horse must not be left alone for a minute, yet it must have a purgative at once. Bill needs a hand here. Luckily the cowhouse is quite near. A shout brings Jack Sharp, the cowman, to the stable. "Will you tell the governor that Prince has colic, Jack?" asks Bill. News of this sort will bring Mr. Bishop in record time.

"All right, Bill, we'll give him a drink. You stop with him whilst I mix up a 'colic drink' with linseed oil," says Mr. Bishop.

Drenching.

Off he goes. When he arrives back with the medicine in a "drenching bottle," Bill has everything ready. He has slung a rope over a beam in the stable roof, made a small loop at one end of the rope and put this loop into Prince's mouth so that the rope is in the empty space between the upper front teeth and the back teeth.

As soon as Mr. Bishop is ready, Bill pulls the other end of the rope and this will of course pull the horse's head upwards by the loop in his upper jaw. The head is pulled up until the mouth is just below the level of the ears. Then Mr. Bishop stands on tip-toe, puts the end of the "drenching bottle" into Prince's mouth (just behind the loop of rope) and very slowly pours in a little medicine. Bill massages the horses' throat with his free hand, Prince swallows and a little more liquid is given. This process is

continued until the dose has been completed. The horse's head is kept up all the time unless he coughs or becomes fractious, when it is lowered at once. It so happens that Prince is a quiet horse and fairly easy to "drench." If he were not the medicine would be given through the rectum by an enæma.

"You carry on with these other horses, Bill, and then go home to breakfast," says Mr. Bishop. "I'll look after Prince whilst your're away."

If the horse is not relieved in about half an hour he will be given another dose. This will be repeated until he is relieved. But he will not be left alone until the cure has been effected.

Other complaints? The usual colds and chills that most animals have, various foot and leg troubles, and cuts and bruises. These last are more troublesome in a horse than in any other animal because of the slow healing nature of horseflesh. Bill is very careful to wash and annoint even the smallest cuts as soon as possible after they are made. But before leaving the question of complaints we shall just watch Bill Lyon give a pill to a horse. In technical terms "give a horse a ball."

A horse ball is used for the purpose of thoroughly purging the animal. It is shaped like a cylinder, about 3 inches long and the same in circumference. Bill puts his left hand into the horse's mouth, through the space where there are no teeth, and takes hold of the horse's tongue. He holds it firmly and pulls it out gently on the right hand side of the mouth. He holds the "horse ball" between the tips of the fingers of his right hand, puts the whole hand down the centre of the mouth and drops the "ball" well behind the back of the tongue. Out comes his hand, the tongue is released and before the horse knows what has happened he has swallowed the ball. All this is completed by Bill in a few seconds.

Some people prefer to use a "balling gun" (the name describes it): this obviates the risk—for the novice—of getting his fingers bitten by the horse.

The most skilled work done by a waggoner when driving horses is when he is handling a plough. Harrowing, drilling corn, making potato rows, horse-hoeing and driving loaded carts or wagons through gateways all require the exercise of skill in different degrees.

An Expert.

Bill is an expert now. He escapes the pitfalls which attend all these jobs. How delighted the boys on the staff would be if, for instance, the great man knocked down a gatepost with a loaded wagon as he passed through, or if he turned his horses too sharply at the end of the field when he was harrowing and pulled the harrows clean over, upside down. And would not the lads be simply convulsed if they noticed, when he was ploughing, that he had allowed a horse to get one of its traces between its legs. Of course they would not dare to say anything to Bill himself about it, but what a joy to see the "oracle" reduced to the ignominy of having to unharness the trace to put it right again.

It would not do for a waggoner ever to admit to the boys that he, in his youth, had ever done such ridiculous things. He did them, of course, and so has every one else who has ever driven horses on the land.

Harrowing.

Harrowing with three horses abreast pulling the harrows is very good practice for the novice. He walks behind the harrows holding the reins and he must drive his horses so that the outside tooth of the harrows travels exactly down the mark made when coming across the field in the opposite direction. If he overlaps, the harrows will not be working to full capacity. If he does not drive close enough, there will be a strip of land which is unharrowed. When he turns at the end of the field he must not pull his horses round too sharply or the centre of "pull" will move too far to one side of the harrows and turn them upside down. He must be careful that the horses do not come backwards when they turn, or the trace chains will become slack, the horses will step over them and there will be a hopeless muddle of legs and trace chains intermingled, with the possibility of one of the horses starting kicking when it feels a chain on the inside of its leg. The horses must be yoked up correctly to the billets or swingletrees and these in turn must be so adjusted that each horse has the same amount of weight to pull. It would be quite easy for one horse out of three to have to pull far more than his fair share, if ordinary care were not exercised.

Drilling.

When corn is sown by a corn-drill, the two travelling wheels of the drill leave a mark on the land. Thus when the waggoner drives his drill back across the field, he sees the wheelmark of his previous journey and that serves as his mark. The coulters of the drill drop the seed into the ground as they cut through it and the straightness of the rows of seed sown depends entirely on how straightly the horses have been driven. If the waggoner has deviated from his mark by a few inches, there will be a strip of land with no seed in it. Such mistakes are not apparent until the seed has grown into a plant; then, of course, the errors become glaring and remain so for the whole growing period of the crop. Yes—one must be able to drive horses with an error of less than an inch in order to make a good job of drilling seeds.

Making Potato Rows.

Making potato rows is somewhat after the style of ploughing. In this case, however, the plough has both a left-hand and a right-hand mould-

board and throws soil to left and right at the same time. Fixed to this plough, called a " ridging " or " earthing " plough, is a long iron rod sticking out on the side of the plough above the ground. At the end of this rod, another bar of iron, pointed at each end, is fixed vertically. This vertical bar can be moved along the horizontal rod at distances between 12 inches and 36 inches from the actual plough. This is known as a marker (" strigger " in north Yorkshire). Its name describes its functions. If, for instance, you want to make rows 27 inches wide, you adjust your marker at a distance of 27 inches from the plough along the horizontal bar. Off you go, making your first row. The pointed end of the marker leaves a scratch on the ground exactly 27 inches from the centre of the row you are making. When you come back across the field to make your next row, you simply drive the plough down the scratched mark on the ground and the marker is also making another scratch for the next row. And so on.

Horse-Hoeing.

With horse-hoeing one must have someone else to lead the horse, unless the crop is sown in a ridge so that the horse can see the depression of the row in the ground and walk along it without being driven. If the crop has been sown on level ground, however, there is nothing to tell the horse where to walk and as the man driving the horse-hoe must keep his eyes closely fixed on the tiny plants growing in lines, an extra hand is needed to guide the horse between the plants. The horse-hoe is for cutting the weeds and moving the soil between the rows of plants. It needs skill in handling or instead of cutting off the weeds you will easily cut off the crop; neither Mr. Bishop nor any other farmer would be particularly pleased with you if you did that.

A Few Hints.

Bill Lyon is a very reticent sort of fellow. It is difficult for him to realize there are people in this country, the leading horse nation of the world, who know nothing about horses. However, for their benefit he has agreed to give a few hints which he hopes will come in useful in emergencies.

" Supposing," he says, " you are taking a horse in a loaded cart down a road covered with ice. The horse slips down and begins to struggle to get up. He cannot get up properly because the weight of the load on the shafts is holding him down. Let me tell you what to do. Just sit on his head. He cannot begin to get up now and you must unyoke him from the cart if you can. If you cannot, keep sitting there until someone arrives to give you a hand in getting him unyoked. Another thing, if the horse has got one of his traces between his legs and is kicking, what then? Hold up one of his fore-feet. You've got him on three legs now and, unless he is an acrobat, he cannot kick. Lastly, if a horse gets into a muddy stream or pond and cannot get out, tie a rope round his neck and with plenty of assistance you can pull him out. But you must be very careful not to make the loop round his neck too tight, and be sure to tie your knot under his chin, then when you begin to pull, his windpipe is free and the whole of the pressure comes on the top of his neck. Don't be afraid that you will hurt him in any way. You won't."

Before the war, the horse population on the land in Great Britain was gradually diminishing. Some say that the days of the horse are numbered and that mechanization will eventually provide more economic power for every kind of job. That day has most certainly not arrived yet! From the sentimental point of view there must be very few farmers or farm workers who will not deplore the arrival of such a day and the passing of one of the finest animals in creation.

THE TRACTOR-DRIVER

The work of George Green—Mr. Bishop's tractor-driver—receives attention in this section. George's main work is on the land itself: he is trained to deal with all the ordinary implements of the farm he has used in the days when they were operated with horses. George is regarded as the machinery expert of the farm. Ploughing with the tractor is compared and contrasted with horse-ploughing. Some difficulties of the job are mentioned by the tractor-driver himself. A knowledge of changing soil- and weather-conditions and their application to implement adjustments are important in the work of a tractor-driver; he must, very often, use his own judgment. There is a discussion about the question "How much can he plough in a day?" After a word about balance ploughs for use with a tractor, there is mention of the fact that 200 working days in a year is the maximum usefulness to be expected of a tractor; this leaves a tractor-driver with a good deal of spare time, in which a handy-man can turn his hand to many other jobs on the farm.

THE uninitiated seem to imagine that the tractor-driver on a farm is a man, wearing very oily overalls, who simply sits on his machine as it goes across a field and back again, pulling a plough or a harrow or a roller or some other farm implement. In short, that his is a rather boring and monotonous kind of a job. In actual practice, he is a very different type of man from what one may imagine. A sketch of the work of George Green (Mr. Bishop's tractor-driver) may throw rather a different light on this subject.

Mr. Bishop has two tractors, each of which is of the ordinary wheeled variety. George Green is constantly pressing the governor to buy a caterpillar-wheeled tractor, but, as such tractors cost most of £1,000 each, Mr. Bishop cannot see that the amount of work to be done on the land he has to cultivate will warrant such expenditure. George cannot, of course, drive two tractors at the same time, but he is nevertheless responsible for the welfare and the ordinary running repairs of both.

The Tractors.

The tractors on Mr. Bishop's farm do not undertake any road haulage. That is either carried out by horses, as far as the nearest railway station, or the produce is collected on the farm by a motor lorry. Consequently, George's main job is concerned with work on the land and this work goes far beyond the mere driving of a tractor.

George is a man of 40. He has been on the land all his life and has held the position of tractor-driver with Mr. Bishop for fifteen years. Before he got that job, he had had a good schooling with all the farm implements and had worked them when they were pulled by horses. Incidentally, the finest training a farm tractor-driver can have. "Why is that?" you ask. The answer is fairly simple. With horses you are always behind the implement which is being used, you are able to watch your tool and to see exactly how it is doing its job. On a tractor you are always in front of the implement, you have to look behind you to watch its work, and as you have to look forward at the same time in order to drive the tractor, it is quite impossible to understand the proper working of the tool behind you, unless you have a thorough knowledge of farm implements before you attempt to use them behind a tractor.

Machinery Expert.

In his capacity as tractor-driver, George is the machinery expert of the farm. The milking machine has gone hopelessly wrong. Send for George. Mr. Bishop's car will not start. Once more, George comes to the rescue. Naturally, with limited tools and with practically no spare parts, he is not able to make all repairs. But he can nearly always tell you what is wrong and if he cannot put it right himself, he can generally tell you what renewals or overhauls are needed, and that is worth a lot when you have to 'phone the nearest engineering works.

Let us assume that the tractor is in good working order. George Green has started ploughing a field and has knocked off for the night. He does not bring his tractor back to its garage. It is winter time, the wheels of the machine will churn up the land on his journey home and do harm. So he drains the radiator into empty buckets, covers the tractor with a cloth and leaves it until to-morrow morning.

There has been quite a sharp frost during the night. George has to break the ice on the water in the buckets before he can refill his radiator. The oil in the engine is very congealed, and it needs a lot of strength to turn the starting handle. He turns for some time. No luck attends him. Feelings must be given vent to, and the tractor is the offending one. George might give it a kick if he did not know that he would be the one to suffer as a result. However, all things come to an end in time. A half hearted splutter, a stronger cough and, at last, the engine is off. The cover is replaced over the tractor and is kept there for two or three minutes until sufficient heat has been generated; then there is a switch over from petrol, which is used for starting only, on to tractor vaporising oil and ploughing is ready to begin.

Ploughing.

The particular plough which is pulled by George's tractor is a double furrow one, that is to say, that it ploughs two furrow at the same time

and like the single furrow horse-plough, it throws the ploughed soil to the right. Incidentally some of the large tractors with caterpillar wheels can plough as many as eight furrows at the same time.

There is considerable controversy as to how many furrows a tractor ought to plough simultaneously. The expert who does the actual work will doubtless throw most light on that matter. " My tractors are 20 h.p. ones of a very popular make," says George. " They could plough three furrows easily enough if I never went below 5 inches in depth when I was ploughing and if the actual furrow was not more than 8 or 9 inches wide. But a great deal of the land I plough has to be done to a depth of from 8 inches to 12 inches, and there are times when the furrows have to be as wide as 12 inches. Under such circumstances my tractor cannot possibly pull more than a double furrow plough, so the governor considers it better to have double furrow ploughs for the tractors."

Principles of Ploughing.

The principles of ploughing by tractor are identical with the same job done by horses. The " rigs are set out " and the " furrows taken up " in just the same way. But when the implement reaches the end of the furrow and is about to turn on " the headland " there is a difference. You will remember that the ploughman with horses presses on the right side plough handle in order to make his plough-share come out of the ground. In the case of a tractor plough, the ploughman is sitting on his tractor *in front* of the implement and in any case there are no handles on a tractor plough. But there is a mechanical device which makes the plough-shares come out of the ground and enables the plough to travel on the land without turning any soil over. This device is put into action by pulling a cord, the end of which is attached to the tractor seat.

George is not a proud man, he is quite willing to admit some of the accidents which occurred when he was a beginner. Let him speak for himself.

Some Queer Accidents.

" Yes—I've had some queer accidents with a tractor when I've been ploughing. All of them when I've been turning at the headland. The whole cause of trouble is this: When you reach the end of the furrow, you must look behind you in order to gauge the exact moment for pulling the cord to fetch the plough out of the ground; and precisely at the same time you must turn the tractor at a right angle. Well—just imagine what it is like, trying to turn a moving tractor like that when you are looking behind you. You may be too anxious, and consequently you may jack your plough up too soon, in which case you will have a headland with furrow ends all over the place, and then you can't plough the headland itself properly when its turn comes. Or you may not turn your tractor quickly enough and will find you have driven right through the hedge before you know where you are. On one occasion I was ploughing in a field adjoining a wide stream. I miscalculated and drove slap into the stream. It took two days to get the tractor out again. As it happens, the governor has driven tractors himself, and as I was only a beginner then, he never said a word. But I don't think he'd be too pleased if I did it now. When the weather is wet, the headland may get very sticky, and in those conditions it takes quite a bit of strength to wrench the steering wheel round."

Knowledge of Farming.

Although George has a very good mechanical sense, it is not for that virtue alone that he holds his job on Mr. Bishop's farm. He also has a sound knowledge of farming operations and of the use and adjustment of all farm implements, arts which take years of experience to master. It is of no use someone taking a course in the mechanism of a tractor and then thinking that he can get a job on a farm as tractor-driver. The tractor is only the motive power, the implement behind it is doing the real work. Weather and soil conditions change very quickly. Frequent adjustments to the implements are most necessary. At times the job itself must be stopped if conditions become unfavourable. To make all these decisions, or at any rate most of them, must be within the capacity of the man on the job. It would be quite impossible for Mr. Bishop to spend his time rushing from one end of his farm to the other all day long, just to see if alterations were necessary. There would be no time left for him to get on with the real management.

A Day's Work.

In cold frosty weather, George leaves the matter of oiling and greasing the tractor and plough until the day has become warmer, but under normal conditions he does this job in the morning before the actual work starts. How much can he plough in a day? This is an extremely difficult question to answer. It depends so much upon the depth to which he is ploughing, the kind of soil and whether the surface is dry or wet. Let us put it this way; a tractor moves at a speed rather quicker than that of a horse. A great deal of time is saved with a tractor when the plough is running empty on the headland and, under normal conditions, a double furrow tractor plough will plough at least three times as much in a day as a single furrow plough drawn by two horses. But, once more, do not lay this down as the criterion. There are many times when the tractor will not accomplish twice as much work as the pair of horses.

The tractor plough which George uses has its mould-boards on the right-hand side and

consequently he can only plough in " gees " and " arves "—you remember this Yorkshireism! —There are also balance ploughs for tractor use. These ploughs are on exactly the same principle as the balance ploughs we have described when dealing with horses. The tractor variety have, of course, the capacity for ploughing more furrows at a time than the single furrow horse balance ploughs. But when a balance plough is used with a tractor, two men have to be employed, one to drive the tractor and the other to tip the plough over at the headland.

Mr. Bishop does not keep a threshing machine. If he did, the tractor-driver would be responsible for it, but we will deal with this later.

200 Days.

On such farms as the one which has been described here, there is a great deal of time in the year when a tractor cannot be used; the land may be too wet to plough or cultivate in any way. All the ploughing may be finished, there is a lapse of time before the spring cultivations start, and so on. In short, on farms where the tractor is not used for road haulage, 200 days' work a year is considered to be its maximum usefulness.

George Green would not have kept his job for fifteen years if he were solely employed upon tractor-driving and the overhaul of farm machinery; half time employed and the other half idle is rather more than any industry can stand. George spends the rest of his time on other jobs on the farm. The fact that he can turn his hand to most jobs on the land is the main reason for his having held his post with Mr. Bishop for such a long time.

SPRINGTIME JOBS

Here is a section which gives us a real breath of country air! It begins with a controversial subject: the tied cottage and that leads on to a mention of the men who, though not responsible for any particular branch of farm work, are yet capable of undertaking temporarily, in such an emergency as sickness, duties which rightly belong to the highly skilled workers: shepherds, cowman and so on. Mr. Bishop looks ahead; he wants clover or a mixture of clover and grass next year in a field now in corn, and so the necessary seed is sown. Technicalities are explained; there is included a lucid account of "broadcasting," a highly skilled job. The sowing of other crops is described. A gross libel is scotched, and there follows, in conclusion a word or two about rolling and the battle against weeds.

ON most farms the specialists, about whom you have been reading, live in cottages on or very near the farm on which they are employed. In fact the living accommodation goes with the job. The rent of the cottage is fixed by law at around three shillings a week; this is more than enough in some cases; it is grossly insufficient in those in which modern conveniences are available. However, there it is!

The law also says that in the case of cottages whose rents are controlled in this way, when the occupant ceases to be employed on that particular farm he must vacate the cottage in favour of the new employee.

Controversial Subject.

A lot of people jump up at once when they hear this. How shocking it is that a man should lose his home when he loses his job! With that point of view, as a farmer myself, I entirely agree. I could write a whole book on the pros and cons of this controversial subject which is absolutely irrelevant to the subject of this book, but I must say that unless there is a great increase of houses for *agricultural workers* I cannot see the solution.

Well—that leads up to the main theme. There is a great number of workers on the land that prefer to have a free hand about their place of employment. Perhaps a rather precarious form of employment. The choice of farms on which they may find work is strictly limited by distance. But in the farm described in this book, a man will find regular employment with Mr. Bishop and will keep it if he is a decent fellow and plays the game.

Mr. Bishop employs five men who do not live in his own cottages. None of them is responsible for any particular department of the farm, but each of them is able to take on, temporarily, one of the specialist's jobs. Bill Lyon has succumbed to a bad dose of 'flu. Sam Thacker looks after the horses until Bill is fit again. When Bill gets back to work he says, "I've never seen horses fall off so quickly in my life." But that is part of the game. Ned Trumper, the shepherd, is laid up. Percy Baldock does his best with the sheep in Ned's absence. The same complaint when Ned is on the job again! Mr. Bishop has to cope with all this as best he can.

However, in spite of these complaints, Sam and Percy are specialists in their own line. What about hedge-laying and what about thatching?

But we must stop all this rambling, and get down to facts. We are starting at the beginning of the farming year, or, shall we not rather say, *of the growing year.* The spring is, of course, the season in which everything, including grass, *a most important crop*, begin to grow.

All land will grow weeds if you leave it untouched. In fact, some genius once said: "The soil is the mother of weeds, the foster-mother of crops," or words to that effect. At any rate we have been talking about *farming* now. Nothing can grow unless seeds are present.

Looking Ahead.

We have described how Bill Lyon drills the corn (oats, rye, wheat or barley). Now another point has arisen. Mr. Bishop has decided that one of the fields sown with corn, shall produce clover or a mixture of clover and grass afterwards—that is to say *next* year. Looking rather a long way ahead, is he not? Yes, he is—but the art of farming lies in looking ahead.

However, the corn is sown for this year's harvest, what are we going to do about the clover and grass seeds for *next* year?

Well—these seeds are sown on the same land that is growing the corn. "Two crops at the same time! Ridiculous!" says the layman. He is not quite right there; the grass and clover seeds crop does not make very big plants to begin with. When they are sown with the corn, they will not mature until the following year. It is hardly fair to call them a crop.

To the uninitiated, a field of grass and clover looks just like an ordinary pasture: he does not realize that it has been specially sown. Or, if the sowing has been done badly, he may notice, right across the field, strips that are quite bare and he may wonder why that has happened.

Sam Thacker generally sows the grass and clover seeds, and a specialized job it is, too. If he makes a mistake, it is there for everyone to see for a year or two, as we have mentioned, because it shews up as a bare strip in the field.

Amount of Seed.

The clover seeds are tiny little things about the size of a pin head, the grass seeds about half the size of a finger-nail paring. The total amount of seed sown per acre does not as a rule exceed 20 lb. so that skill is needed in putting on exactly the correct amount of seed. Now there are several ways in which the sowing can be done.

One way is by using a special seeds-drill drawn by a horse; this is probably the easiest and best way of doing the job, though few farmers keep an implement that only works for a few days in the year.

Then there is the hand " fiddle " drill, so called because it is operated by a " bow " very like a violin bow and the motion of working it is identical with the motion of fiddling. Another tool is the " seed barrow "; this is pushed by hand. Again the name describes it. It is a wheelbarrow on the top of which is fixed a long narrow box containing the seed. The mechanism forces the seed out of small holes as the barrow moves along. This seed drops onto the ground, where it is immediately covered and pressed into the soil by harrows and a roller following the sower, all being tractor or horse-drawn. Lastly, there is the method of sowing by hand, usually termed " broadcasting," one of the most highly skilled jobs on a farm.

Broadcasting.

Sam can use any of the devices just described, but prefers to sow by hand. We shall just go down to the field with him and watch him. It is of course a perfectly still day. Gusts of wind would blow these tiny seeds all over the place and would result in portions of the field having no seed at all.

Sam has with him a deep tray made either of wood or galvanized iron, and known as a " seed hopper " or a " seed cord "—according to whether you live in Yorkshire or Kent. This tray is curved and has attachments which Sam straps round his shoulders. Thus he has a receptacle in front of him which holds the seed.

Before he starts " broadcasting," he cuts some long sticks, to the ends of which he ties either white paper or white cloth. Having prepared his sticks he sets them up in line 2½ yards from and parallel with the hedge. Thus he has a line down which he will walk when he starts sowing. Now the real skill begins to be shewn. Before he starts, Sam takes a pinch of seed from the " hopper " between the thumb and forefinger of his right hand. Then he brings his right hand back to his side. After putting his left hand in the tray, ready to pick up seed, he moves off, left foot first. As his left foot comes forward so does his right hand, scattering the seed at the seed at the same time. Meanwhile, his left hand picks up seed and is brought back to his side. Thus, when his first stride is completed and the right foot ready to move forward, his left hand is ready to sow, and his right hand ready to pick up more seed. And so on.

Perfect Unison.

As you watch him you will see his arms swinging in perfect unison with the strides he is taking. When he arrives at the first stick in his line, he stops and replaces it 5 yards further into the field. Why 5 yards when he made his first line 2½ yards from the hedge? Surely that's easy. He is sowing seeds on all the land 2½ yards on each side of the line of sticks. When he comes back down the fresh line he will do the same, thus the total width is 5 yards.

" Now tell me, Sam," you say. " How can you gauge whether you are sowing 15 lb. or 20 lb. of seed to the acre? You must dip your hands into the hopper many times when you traverse an acre, half a saltspoonful of seed each time would make an enormous difference to the total."

" Well," replies Sam. " I can't explain it. I just *know* how much to take each time, and that knowledge comes from experience." Perhaps not a very lucid answer, but it is very doubtful if there is a better.

Sometimes Sam broadcasts corn. Exactly the same principles apply as with grass and clover seeds, though in the case of corn he will be sowing 1½ to 2 cwt. of seed per acre as against 20 lb., and the larger quantity gives him rather a wider margin of error.

Other Seeds.

The sowing of other seeds such as mangolds, swedes, kale and the like is carried out by a drill, usually horse-drawn, the idea being the same as in the case of the corn drill which we described earlier. But potato planting is rather different. Although there are machines to do this job, the great bulk of potato planting is still done by hand.

Let us pay a visit to Mr. Bishop who grows 50 acres of potatoes and watch the planters at work. The potato rows have been made by Bill Lyon, the artificial manure has been sown by a specially constructed drill and the dung has been ploughed in to the land the previous autumn and is now thoroughly mixed with the soil. In short, the stage is set for putting in the seed.

Planting Potatoes.

In one field are eight women planters who each have a bucket or basket. The bags of seed potatoes are placed at intervals along the potato rows stretching across the field. The women fill their buckets from a bag near the hedge and set off across the field, each woman having a potato row to herself. She carries the bucket in one hand, fills the other hand with as many potatoes as she can hold and drops a potato every 12 to 15 inches as she walks down the row. Incidentally Mr. Bishop decides upon the distance between each seed potato (a very important part of the management this) and gives instructions to that effect. When the woman has planted her handful, she stops, takes another handful from the bucket and starts off again. And so on until the bucket is empty. She then stops and fills her bucket again from the nearest bag of seed potatoes.

How much can a woman plant in a day? As in

most jobs in farming there is no certain amount. Obviously waste of time occurs when the bucket is being refilled, and during the slight pause to pick another handful from the bucket. A step further: the bigger the potatoes, the fewer there will be in a bucket or in a handful, thus more frequent stops will be necessary. However, with standard size seed potatoes, a woman would be considered to have done well to plant an acre in seven hours.

In an adjoining field are half a dozen men. All of them really expert potato planters. Men who can each, at a pinch, plant two acres in ten hours. Is there any special technique? Well—yes there is. The secret of course is in minimising the delays in filling a bucket or in grasping a handful.

Expert Planting.

Each man has made a kind of apron from sacking. This apron is about 5 feet long and 3 feet wide. He has tied the middle of the apron round his waist quite loosely with string. Each corner of the apron has a strong piece of string tied to it, then the strings at the top side of the apron are tied together in a loop and so are those at the bottom. The man then puts the top loop over his head so that the top part of the apron now hangs from his shoulders. He kneels on the ground pushing out the bottom of the apron in front of him empties about 3 stones of seed potatoes out of the bag onto the stretched out apron and then puts the bottom loop of string over his head to rest on his shoulders. When he stands up both his hands are free, yet he is carrying in his apron about twice as many potatoes as he could in a bucket, and remember that this, at the same time, would occupy one of his hands.

He is ready to start now. One hand dips into the side of the apron and takes a handful of seed. Whilst he is planting these, the other hand is picking up more seed on the other side of the apron. Thus he does not stop each time his hand becomes empty but can keep moving all the time he has any seed potatoes left in his apron. The expert who was paid at the rate of 12/- an acre for planting potatoes would expect to earn at least £1 a day at the job; and, to my mind, it is nowhere near such hard work as when an ordinary bucket is used.

As soon as the potatoes are planted in the rows, they are covered with soil. This is quite simple. The ridging plough (the one with a mould-board on each side) is driven down the middle of the small ridge formed between the rows. The plough splits this ridge and thus the potatoes are covered up.

Harvesting.

One hears a great deal about the vital importance of harvesting the crops. It is certainly a most urgent job, but in my opinion, the actual sowing of the crops is much more important. A bad harvest will certainly affect the quality of the produce and may in some cases lower the yield, but a bad sowing time will, beyond any shadow of doubt, reduce very materially the ultimate yields and in some cases will mean no crop at all. It will therefore be clear why everyone on the land gets on with the job of sowing and planting in the springtime to the best of his or her ability.

If we reckon springtime to end about the middle of May, we shall find that most of the crops have been sown or planted by that time; and then there certainly is, in most seasons, quite a pause in the really vital work connected with the growing of crops.

That does not mean, of course, that everyone on the farm sits back and says, " Ah—now we have got the crops sown, the rest lies with nature. What about a trip off to the seaside? " or that the skilled men, and they really are craftsmen, lean over gates smoking pipes, conducting a conversation on these lines:—

" That be a foine crop, that be, Jarge."

Gross Libel.

" Ah, to be sure it be, 'Enry." This type of thing is a gross libel on the intelligence of the ordinary man engaged in farming, an intelligence by the way, which compares very favourably with that of any other section of the community.

" But what work is done during this somewhat easier time after the crops are sown? "

The most important of these jobs is rolling. Quite a simple job really and an excellent one to give the novice training in handling horses or a tractor. Farm rollers may be either horse- or mechanically-driven.

Battle Against Weeds.

Then there is the preparation of land for the few crops which are sown late, sometimes up to the end of June. And lastly, the eternal battle against weeds, the chief of which at this time of the year is the thistle.

The next time you see a line of people, armed with hoes, walking across a field of young corn occasionally stabbing at something in the growing crop, you will realize that they are spudding thistles and not taking a little exercise in the sunshine. The potato crops, mangolds, kale, sugar beet and other root crops must be horse-hoed.

Mrs. Bishop, who knows the position, will be sure to suggest to her husband that " It is high time the stack-yard and buildings had a much needed ' tidy-up ' and if they aren't too busy on the farm, what about it? "

And, of course, the work with the animals goes on all the year round.

SUMMER WORK

Perhaps most familiar to the town dweller of all the work that is done on a farm is that which occupies the summer months. In this section some of it is detailed. First there is the Hay Harvest and all the complications that accompany its complete success—or comparative failure—mowing and the horse-mower, the art of scything, turning—and on to stacking, and all about the difficulties and disappointments too, and at last there is an audible sigh of relief for haytime is finished. Hoeing must now be undertaken, at least in the mangolds and sugar beet, and the potatoes have to be earthed up for the last time. Then, too, the turnips must be singled and there is transplanting to do. Last of all we hear about Mr. Bishop's pea-growing and its hazards but surely there is no more popular vegetable!

The Hay.

On most farms the first crop of the year to be harvested is the hay. Here is one of the most worrying jobs on the farm, and it must be remembered that there are usually several other important operations which must also be done at this season of the year. The least shower brings haymaking to a stop at once and a period of wet weather can easily ruin the crop completely. There is very sound commonsense in the old adage, " Make hay while the sun shines."

If hay is spoilt by human agency the master himself is invariably the culprit. We will follow Mr. Bishop through a really tricky haytime and see what he does. He grows about 50 acres for hay. He also has an enormous amount of other work on hand at the same time—sugar beet singling, potato hoeing, pea picking and the planting out of broccoli, savoys and the like. He employs a lot of labour but he is also a business man and knows perfectly well that no industry can stand being over-staffed. Consequently, as it is quite impossible for him to find another six or eight hands for the haymaking he must make do with the labour he has got.

Skill of the Master.

So now, for a change, we are going to talk about the skill of the master himself.

" I say, Mr. Bishop, how do you know when the grass is ready for mowing? " is our first question.

" It's ready for mowing as soon as the seeds on the rye-grasses begin to lose their green colour and, if clover is present, as soon as the clovers are in full flower. How can I spot that? Years of practice and experience, must be the answer. When the hay is really made and we start stacking it, we cannot shift more than ten acres a day on this farm, so we try never to have more than twenty acres, two days' stacking, mown at one and the same time. The damage to hay from the weather, is most done between mowing and stacking. I never like having too much hay at the mercy of the weather at any given time. Thus we must mow the different fields at intervals. We do not want the last lot to get too ripe before it is mown, so we start on the first field just before it is really ready. You see—the whole lot will become ready for mowing at the same time. And lastly, we try, as far as possible, to avoid having hay ready for stacking on a Sunday. If the weather is anything like normal, the new mown grass will be turned into hay in about five days, so if we mow on a Friday or a Saturday, we hope to be able to get it the following Wednesday or Thursday. Tuesday's mowing might be ready on a Sunday. You see that, don't you? Just a small point, but one worth remembering. However, I've given orders for a start to be made with mowing a 20-acre field to-morrow (Friday). Come along and see how we do it."

Mowing.

It is a beautiful morning the next day, rather a lot of dew, but that does not matter as far as the actual mowing goes. Bill Lyon has arrived with a pair of horses and a mowing machine, George Green is there with the tractor complete with its mowing attachment. Barring accidents they will not have the slightest difficulty in mowing 20 acres of grass during the day. Whether horse-driven or tractor-driven, the principles of the mowing machine are the same. It is simply a mechanical method of cutting off the growing grass. The basic idea is the same as in the clippers with which a barber cuts hair, a series of sharp edged knives which move very quickly from side to side as the clipper goes forward. Grass is somewhat tougher than human hair, it blunts the knives much more quickly, so the mowing machine has several spare knife bars, and as each of these become blunt, a fresh one is inserted, and an extra man sharpens the blunt ones up again with a file.

A mowing machine does not cut the grass in a direct line behind the horses or tractor pulling it. The motive power is obviously in front of the machine, but the cutting knife is either on the right or the left of the actual mower.

In order to illustrate this we shall watch Bill Lyon make a start on the meadow with the horses.

The Mower.

The long grass which is to be mown, grows right up to the edge or fence surrounding the field. Bill has harnessed two horses to the mower —one which will cut a width of five feet (the tractor will take a machine cutting 7 or 8 feet wide). He starts off at one corner of the field and drives his horses right round the field as close to the hedge as he can. The space occupied by the two horses abreast is roughly five feet, and we know that the machine is not cutting in a direct line behind the motive power.

Consequently, after he has been round the field once he has mown a strip five feet wide, called a "swath," but there is another *unmown* strip of the same width adjoining the hedge which has been trampled down by the horses. When the machine goes round the field the next time, the horses are walking on the "swath" made on the previous journey and no damage is done. In order to mow the outside strip next to the hedge, Bill simply drives his mower the reverse way round the field. Just think that out, it isn't very difficult to follow.

The mowing machine can be adjusted to cut the grass about one inch from the ground level and of course every farmer wants as much as he can get from a hay field.

Why is Mr. Bishop so irritated as he looks across his meadow? There are huge patches of grass, all over the field, which have been completely flattened. The mowing machine cannot possibly cut them; it will simply go over the top of them.

A Day in the Country.

Here is the answer: Father, mother, children and a friend or two have been spending a day in the country. They really are most conscientious folk. They never forget to close a gate, they would not dream of breaking down a fence, but here is a most glorious sweet-smelling field. No animals in it. "Let us have a picnic here!"

What would they say if Mr. Bishop decided to have an outing with his staff and picked on their garden as a handy spot for tea?

Anyhow, that is how the grass is cut for hay-making. Before mowers were invented, the cutting was done with a scythe. There is not a great deal of scything done on a farm nowadays. A certain amount in haytime on steep banks or in other awkward places where a machine cannot be used. During the corn harvest, a scythe is still used quite a lot.

What, it may be asked, are the essentials of scything? Primarily a sharp blade. By the way, in case there may be anyone who does not know what a scythe looks like, here is a brief description. A curved piece of wood on which are fixed two other short pieces of wood which serve as hand grips, and a metal blade, some 4 feet in length, fastened to the end of the curved piece. The metal blade is, of course, the cutting part of the scythe, one end is called the point (and this describes it) the other end is called the heel.

The Art of Scything.

The art of scything lies in making the tool do a slice rather than a direct cut, and as you make the semi-circular sweep you will find that the drag on the blade caused by the cutting will tend to make the point of the scythe go into the ground, whereas it should skim over the top of it. How can you counteract this? When you hold your scythe by the two hand-grips, your right hand is lower down the shaft than the left. Press down with the right hand and pull slightly with the left hand. This will keep the "heel" of the scythe on the ground and will keep the point out of it.

A lawn mower, which cuts grass on an entirely different principle from the ordinary grass mower, must be an exception when I say that, so far, no implement has yet been devised which can cut grass or corn so close to the ground as can a scythe if properly handled.

Expert scythers say that they can cut an acre of grass a day. I cannot dispute that; I have never tried to do it.

Mr. Bishop's plan for mowing his first 20 acres for hay goes according to schedule. The mowing is by far the easiest part of haytime; what a simple job the hay harvest would be if there was nothing worse than that. The next two days are lovely. Hot sun and a light breeze. On the third day, Mr. Bishop says, "We'd better have that hay turned." Quite an easy job nowadays, a machine (generally horse-drawn) simply turns the "swaths" upside down and exposes the still damp part underneath to the sun and wind.

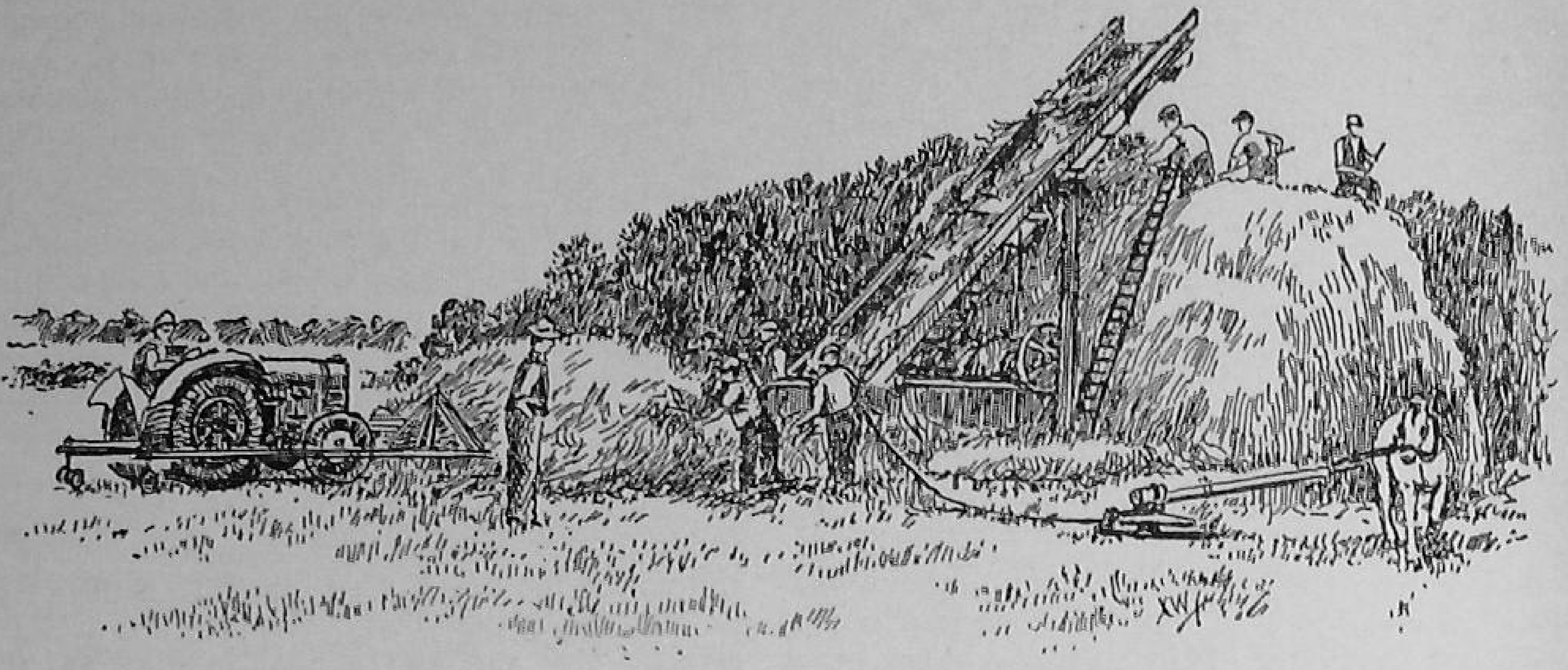
Judgment.

Now comes one of those worrying periods which brings the grey hairs to Mr. Bishop's head and "crows' feet" to his face. When has the grass really become hay? Should he stack the hay direct from the "swath" or shall he make hay cocks (miniature stacks) of it? No text-book can tell him this. It rests solely with his judgment. If he puts the hay into a stack before it is really ready, the stack will become heated, and perhaps catch fire as a result of spontaneous combustion. If he leaves it too long the hay will lose a very large proportion of its nutritional value. It is a matter of hours only during which the hay is just right.

Well—he must not waver in his decision. His prestige with the staff will go down enormously if he gives the wrong order, but there it is. Sink or swim—"We will stack that hay to-day," he says.

There is still too much dew on the hay for a start to be made early in the morning, but there are plenty of other jobs on hand to fill in the time. First of all the size of the stack must be arranged before a start can be made. Charlie Gains is Mr. Bishop's expert stacker. A short consultation takes place. Mr. Bishop then says, "All right, Charlie, we'll make the stack ten yards by five." And this is what he means. The length of the bottom of the stack is to be ten yards and the width five yards. Charlie gets four sticks, paces out the required distances and sets up a stick at each corner of the rectangle that is to comprise the base of the stack.

It is no good starting to build a stack with the intial layers of hay directly on the ground; if you do this the damp, striking upwards, will ruin the bottom of the stack. Therefore a thick layer of



STACKING HAY

wheat straw is put over the whole of the site for the stack.

Elevator.

In the meantime that large implement known as an elevator, is drawn near the side of the stack bottom. The name describes it. It is a mechanical contrivance, on the same principle as the moving stairs in the " tube," and this will take up the hay to the required height after it has been thrown onto the bottom " stair." A small petrol engine or a horse provides the motive power for this machine.

It is a fine morning with a slight breeze, and by 9 a.m. the dew has evaporated. George Green starts up the tractor and attaches the " sweep " to the front of it. Once again the name describes the tool. It sweeps up the hay into large heaps and carries these heaps to the stack. Incidentally the " hay sweep " is one of the very few farm tools which are pushed: practically all agricultural implements are pulled.

George drives off to the far side of the field, turns round, puts his " sweep " into action and drives back to the stack, gathering more and more hay as he proceeds. He drives up to the side of the stack, reverses his tractor and pulls the " sweep " out from under the heap of hay he has collected, then off back to the other side of the field for some more.

Standing beside the stack are two of the strongest men on the farm with a fork each; their job is to pitch the hay onto the stack and they will have the hardest work of all. When the stack is in its infancy, there is no point in using the elevator because the stack is so low that the pitchers have not to throw upwards at all. It is brought into use when the stack is about six feet high.

On the stack itself are Charlie Gains and three helpers; this makes a total team of seven, plus the machinery.

Making the Stack.

Now let us watch the expert making the stack. The three helpers on the stack pass on to Charlie the forkfuls of hay, as they receive them from the pitchers. Charlie starts building his stack by heaping up all the first forkfuls of hay in the *middle* of the stack bottom. The succeeding forkfuls are placed round, and slightly overlapping, the initial heap. Thus this heap is gradually extended by building outwards from the *middle* until the whole of the stack bottom is covered by hay. And this is a point missed by many stackers, the middle of the stack, or rather, the middle of each course of hay put onto the stack, must be kept considerably higher than the outside layers. Thus at any given time during the erection of a stack, the top should never be flat, it should always be highest in the middle.

Why? Well—that is quite an easy one to answer. The higher the stack gets, the greater is the weight pressing downwards and as the hay is quite loose when it is forked on, it is obvious that as soon as the weight increases, a great deal of compression takes place. The greatest weight is in the centre where in consequence the greatest compression take place. The stack which has been built evenly upwards from the bottom will sink down in the middle when the compression takes place and will have a concave appearance. Thus if any rain does penetrate the stack, it seeps right into the middle from whence it filters right down to the bottom and ruins the whole lot. Whereas in the properly built stack, which is always higher in the middle (even after it has settled down) any water will always run from the middle to the outside.

Charlie will keep coming down from the stack to have a look at it from the ground, just to make sure that the sides are straight and that the stack is not starting to lean in one direction or another. When there still remains rather more than a quarter of the total amount of hay in the field

still to be stacked, Charlie begins to make the roof of the stack. He begins doing this by making the middle even higher than before, but when he places the outside layer of hay in position he does not put this exactly on the top of the layer below. He puts it slightly nearer the centre of the stack and thus begins the slope of the roof; and so on until the final layer goes on the very crest of the roof, away up some 30 feet from the ground.

At 9 p.m. the job is finished, and so to supper and to bed.

In about a week's time the natural compression of the stack will have brought the total height down from 30 feet to about 20 feet. There will be a certain amount of " sweating " in the hay and we shall smell the most perfect of all scents, peculiar to well-made hay.

Using the Fork.

A little tip on how to handle a fork may be given before we deal with the complications of hay-making. A right-handed person will instictively grasp the handle of a fork with his right hand (knuckles upper-most) near the top of the shaft of the fork and his left hand (knuckles downwards) about three feet further down. The right arm is then doing most of the work, the left hand is simply acting as a fulcrum. Now the tip is this, if you are going to do much forking, you must get used to holding the fork with the left hand near the top of the handle (" shaft," in farming circles) and the right hand lower down. Next time you see experts doing any fork work, just watch them and you will notice that they change hands every quarter of an hour or so. The correct way to swing the fork when you are pitching can only be acquired by practice. It cannot be described by writing, copy the craftsman and if you succeed you will find that what, to the novice, is the most exhausting work has become something well within your power.

And now—back to Mr. Bishop's hay. His first field has been cleared and stacked in grand fettle. He has mown a further 20 acres, and is considering the possibility of being able to stack it in two days' time. The weather looks set fair. Shall he take a risk and mow his remaining 20 acres which is now absolutely ready for mowing? Not a man of his experience. One job at a time, if possible, is his motto.

Difficulties.

Everything is ready, when down comes the rain. This means not only a delay in operations, far worse than that, it means a very rapid deterioration in the quality of the mown hay.

What would you feel like if you were selected for the first eleven at cricket owing to the illness of one of the regular members? Each match is rained off. The sick man is rapidly getting better and your chances of showing what you can do are equally quickly disappearing. Any remarks about the weather? Do you blame the farming community if they state their views about it?

Meanwhile, Mr. Bishop's hay is spoiling. It does not rain all the time, but the hay is never really dry for a week. By then, the grass still to be mown has begun to die before it is cut; and in consequence it too is deteriorating. There is only one thing for it. Get on with mowing the standing grass, no matter what the weather may be.

Well—you can mow grass when it is wet, so that is not a serious difficulty. The rain still keeps falling. A growth of new grass has pushed its way through the " swaths " which have now been cut a fortnight. Suddenly the weather clears up temporarily. Every available machine is set to work to turn the hay. A good strong wind springs up. But although the hay may now feel dry enough to the novice, the expert knows that it still contains too much moisture for stacking.

" Horse-Rake."

Out go the orders to rake up the field. The very name of the implement known as a " horse-rake" describes it, although in these days of mechanization " tractor rakes " are also on the market. The hay is raked up into windrows, all available hands are put on to work making haycocks. A haycock is simply a miniature round stack and is built by a man with a fork. Bearing in mind the fact that it may start raining again as soon as the haycocks are made, these must obviously be made so that rain will not penetrate. Exactly the same principles, as in stacking, apply. Make the centre of your haycock the highest part right away from the start. Much more easily said than done but once again experience makes perfect. Even these seemingly simple jobs take quite a lot of mastering.

All the hay has been cocked. Mr. Bishop just wants another fine day or two to dry it up thoroughly in the cocks and then he can stack the lot. It is only in a story-book that things go as required. Down comes the rain again. But this time there will not be so much damage. None of the inside portions of the haycocks will get wet, though the outsides will naturally go on deteriorating.

" But why on earth does he not put his hay into small cocks as soon as he cuts it? " you ask. " Surely this would prevent all this damage from rain."

Yes—you are right in one respect. The rain would not hurt it much. But the grass must be turned into hay before you put it into the smallest heap. Have you ever made a small heap of cut grass from your lawn? Have you not noticed how quickly it gets hot and ferments."

PLANTING OUT

Haytime is Finished.

An audible sigh of relief goes up from everyone on the farm. At last haytime is finished. Some of the hay is of poor quality, but that must be scored up against the Clerk of the Weather. No chance of a breather at this time of the year. There is hoeing galore, mangolds, sugar beet and what not. The potatoes have now grown until the leaves of the plants are nearly meeting across the rows; they must be soiled up for the last time. Why—and what *is* that? Well—the original rows have now been hoed level either by hand or horse. The tubers are beginning to swell. Exposure to the air will soon turn a potato green and make it unfit to eat. Thus you must put as much soil as possible in the place where the tubers are growing, in the hope that none will push so near the surface as to come through the soil even when they are fully grown. The same plough (the double mould-board one) as made the original rows does this job also.

Singling Turnips.

Another rather laborious piece of work is on hand at this time of the year, " singling " turnips. " Singling " means just what it says, i.e. hoeing out clusters of plants and leaving one. You see —a turnip seed is about the size of a pin-head and, so far, no machine has been invented which can sow minute seeds like these one at a time every ten or twelve inches. In practice the seed is sown at the rate of two to three pounds per acre and this results in a plant every half-inch or thereabouts. Now, if you want a good crop of turnips, the finished root should be about as big as your head. Rather quick work this from a pin-head to that size in under six months, but these are the facts. At any rate, your plants must be ten to twelve inches apart if you want to achieve this. Hence we carry out " singling." It is quite a skilled job, but one which can be acquired fairly quickly. " What are the main points in singling? "

Easily the first one is a sharp hoe, some seven or eight inches wide. Next the ability to hoe as you pull your hoe and as you push. Do not confuse this with the pushing of a " Dutch hoe," quite a different tool. I mean hoeing by the back of the hoe as you push it. Once more it is a question of skill. You pull or push your hoe through a cluster of plants as you stand sideways to the row you are hoeing. You may leave three tiny plants (they should not be more than two inches tall) and, when you are experienced, you do not have to stop and think which plant you are going to leave and which two you will hoe out. You know automatically.

Just watch an expert doing this when you have a chance. Ask him to let you have a shot for ten minutes. By the end of that time you know whether you will ever make a good " singler " or not. If you are still making a hash of it or at any rate, getting on very slowly, after ten minutes practice, you never will become an expert.

Once more, it is dangerous to set a standard for " singling." Shall we say that in loose soil, with little or no weeds, it would take a very good man indeed to single more than half-an-acre in nine hours.

Mr. Bishop grows ten acres of broccoli on his farm. He sows the seed in a special seed bed in the beginning of April and by the end of June these seeds will have turned into plants about 4 or 5 inches tall. It is time for them to be transplanted.

Transplanting.

We are not dealing with the necessary cultivations for every individual crop in this book, so let us assume that on the broccoli field all these have been done, that there has been some rain. That it is time for the job of transplanting to be undertaken.

The field has been specially marked out. An implement which makes scratches in the soil has been over the field lengthways and crossways. Consequently the land is marked out into little squares (of about 2 feet 6 inches each way) and at each corner of these squares a plant will be put in.

At the plant bed itself are half a dozen women who pull up the young plants from the ground and pack them into hampers or bags. These receptacles are taken across to the field where the crop is to be grown and are placed at intervals across it.

There are four women and eight men here. Each of the women takes a good handful of plants and drops one at each appointed place as she walks across the field. The men have a " dibber " each, a short, pointed piece of wood shod with iron and having a handle on the top.

When the women have got a start with laying out the plants, the men begin the actual planting. If you are the planter you pick up the plant from the ground with one hand, thrust your dibber into the soil and put the root of the plant into the hole you have made when you draw the dibber out. A short jab on the side of the hole with the dibber to press the soil back into the hole, a stride forward to the next plant and a hard stamp with your heel against the base of the plant you have just put in—well, that is all there is to it.

The Secret.

I have very decided views on this question of transplanting and must give them for what they are worth. To my mind, if the subsoil moisture is sufficient, the secret of successful planting-out lies in having the soil firm both before planting and after. I see scores of allotment holders putting the plants in and religiously watering and watering and watering. We cannot do this on a farm (where incidentally the bulk of vegetables sold in shops is grown). Yet, as a rule, the farms grow better vegetables than any garden. Cannot they use a roller on the allotment to consolidate the soil? That is how we manage things on a farm. And what about saving the time of this everlasting watering!

There have been, in the past, and no doubt will be in the future, many conjectures amongst experts as to how many plants a man can set out in an hour. I have heard all sorts of figures mentioned, and if a man simply goes all out for an hour, he can, of course, put up a very good performance. But when he is keeping at it all day long (and it is rather a back-aching job) no one grumbles if he puts in 700 plants an hour.

Green Peas.

Another market-garden crop, easily the most popular vegetable of them all: green peas. And what is nicer? Mr. Bishop grows this crop along with his other activities. He grows the same varieties as are grown in gardens. Of course he could not cope with the job of putting up sticks for the peas to climb: they have to manage without these adjuncts.

And now to digress once more: Many greengrocers put up a notice " Garden peas " alongside the green peas they are offering for sale. Why that should be an inducement for people to buy such peas, I do not know. Speaking personally, it would be against them if I were a buyer. Why? Well—nearly a hundred per cent of the peas sold in greengrocers' shops is grown in fields, and from what I have sampled and tasted myself, the flavour of peas grown in open fields is far superior to that of the same variety of pea grown in gardens. Perhaps the answer is that one grower is a professional and the other is an amateur.

At any rate, Mr. Bishop is a professional. He sows a fixed number of acres of peas at weekly intervals from the middle of March till the beginning of June in the hope that they will ripen at weekly intervals from the middle of June to the end of August. Farming being what it is, this delightful arrangement nearly always goes awry. Sometimes three separate sowings of peas, spread over three weeks, all come ripe together; some times the last sowings never ripen at all and there is no crop. However, he knows all about these hazards and as he has a gambler's instinct he continues to grow the crop! What a sheer gamble it is! Some people back horses, some people grow green peas. There is not much difference between them.

However, the first batch of peas is ready for picking. " When are they ready? " (*That's an awkward one*!) A little explantion may be given first: The pea plant (known as the straw or haulm) may have from one to eight pods on it; the pods nearest the ground always fill up first. Thus, it is quite easy to find pea pods, at the bottom of the straw, over-ripe and the pods at the top of the straw quite flat with practically nothing in them. The ideal way of picking peas would be to rake off the full pods at the bottom of the straw and pick the flat pods later on when they had filled. This procedure might work if all the pickers were skilled and were careful not to trample the growing crop down, but on Mr. Bishop's farm it cannot be done.

PEA PICKING

With a large acreage such as he has, he must employ a large amount of labour and this labour is mostly unskilled. He has to clear a crop as he goes on. So now we come back to the question as to when the peas are ready for picking.

Briefly, as soon as the bottom pods on the straw show the slightest sign of turning grey in colour. It doesn't matter what the top pods are like. There should never be a grey coloured pod in the sample.

And here is a little hint to the housewife when she goes shopping. Don't object to seeing a few flat pods amongst the peas. It is a sign that the peas are young.

Picking.

And now let us turn to the job of picking. Mr. Bishop's farm is five miles from the local market town. He needs nearly 200 pickers, and as he draws his labour from the town he must provide conveyances to get them out to the farm and take them home again. An arrangement has been made with a local bus company. Shortly after 6 a.m. on the day appointed for the pea-picking the empty buses draw up in the market-place. A crowd of women, children, old age pensioners, and a few men are waiting. What a scramble and what a crush. Perambulators, empty buckets and baskets, collapsible chairs and human beings pack onto the buses somehow.

Off they go on a most beautiful summer morning for a day in the country. Pea-picking is one of the most delightful jobs in farming, and one of the most popular. A woman in a town can take her children with her for a day in the fresh air. The little ones can help for an hour or two until they get tired or bored and the whole family can spend the day in the open and can earn quite a tidy little sum of money into the bargain at a very easy job.

The buses arrive at the gate of the field where the peas are. Mr. Bishop and half a dozen men are there to greet the pickers.

The Pickers.

" Good morning, sir," comes a general chorus.

" Good morning to you," is the reply. "Hope you'll not allow the children to do any damage to the peas."

There are nearly 200 pickers and they are instructed to line up about one yard apart along the hedge on one side of the field. It is nearly 7 a.m. now, and the work of the day begins. Each picker has her strip of growing peas about a yard in width and she will clear that strip right across the field. She pulls the haulms out of the ground, by the roots, with one hand and pulls the pods off the straw with the other. As she picks off the pods she drops them into her bucket or basket. When this bucket is full she empties it into a special pea bag with which each picker is provided when she enters the field.

If the crop is thick and there are not too many weeds (though the pea crop seems to encourage more weeds than any other crop) a good picker will pick a bag of 40 lb. of peas in an hour. Incidentally, green peas are usually sold in bags weighing about 40 lb. each in most of the wholesale vegetable markets of this country.

The half-dozen men who were with Mr. Bishop

have definite jobs. They are each in charge of a section of the pickers, roughly thirty to forty pickers in each section. Their duties are to heap up the pea haulm behind the pickers when it has been cleared of pods, to see that no pods have been left on the straw, to make sure that no growing straw has not been pulled up by the roots, and generally to keep a fatherly eye on the pickers. This last duty of course involves a good deal of good humoured back-chat.

Weighing.

At about 8-30 a.m. many of the pickers, or parties of pickers, have several bags of peas ready. Some more of the farm staff arrive upon the scene complete with weighing apparatus; they set up this apparatus at some convenient place behind the line of pickers, and make it known that they are ready. The pickers bring their full bags up to the scales where the peas are inspected and the weight checked. If everything is correct, the picker then receives the money to which she is entitled.

There is something very nice about starting work at 6-30 a.m. and beginning to draw good solid cash for your labours at 8-30 a.m. And the cash is very handy when the ice-cream salesman and the lemonade and sweet vendors arrive on the scene later in the morning when the sun has become warm.

The buses arrive about 4 p.m. to take the pickers home. Those who have not filled their bags are paid for the portion which they have picked; instructions are given concerning the next day's picking and that is the end of the work for the day. Rather more than 20 tons of peas have been picked and are in the bags. Not a bad day's work.

Transport.

Transport has been arranged to take the peas to London. The motor lorries are loaded later in the evening ready for their night journey to the Metropolis. The peas will be on sale at dawn the next morning in Covent Garden and the other big wholesale markets, the greengrocers will have them in their windows by 9 a.m. and many of them will be cooked and eaten for lunch. Rather a good distributing organization, I think.

Among the hazards of pea-growing is the extreme perishability of the crop. A pea is at its best, from an eating point of view, for three days only, after which it rapidly becomes hard and "corney" and loses its flavour. A little too much rain to prevent the picking at the psychological moment, a delay in transport services to take the crop to the market, anything in fact that holds up the sequence of events leading from field to table causes an extremely rapid deterioration in this valuable farm produce.

THE CORN HARVEST

The farmer generally has a chance to concentrate on this big piece of work because other things are either finished or not yet due to be undertaken. This section unfolds for us the course of the various harvest operations: "opening out" a cornfield—tying up—work with the binder—then stooking—dealing with laid corn—stacking—thatching—and hints thrown in here and there.

In farming circles the term "harvest" means the corn harvest, and it certainly does involve one of the biggest jobs of the year on the ordinary mixed farm.

Fortunately, on most arable farms, when the time comes round, one can concentrate entirely on the corn harvest. Hay-time is usually finished, and so are the cultivations and necessary cleanings in connection with other crops, whilst the harvesting of most of the root crops does not take place until later in the autumn.

Beginning of Harvest.

Well—here we are at the beginning of harvest on Mr. Bishop's farm. The crops are good ones, some a bit too good. Since this seems rather a paradox, a little explanation is required. Extremely heavy crops of corn are rather liable to become top-heavy, that is to say, the weight of the grain in the ear may be too heavy for the straw; thus when there is a thunderstorm accompanied by wind, a heavy corn crop is liable to be beaten down flat upon the ground (technically called "laid" or "lodged") and serious damage affecting both quality and quantity will then ensue. I mention this because the method of handling "laid" crops will shortly be explained.

The first fields of corn ready for cutting on Mr. Bishop's place are luckily undamaged so far by wind or rain. It is a Wednesday morning and Mr. Bishop has decided to start cutting corn the next day. These are his order on that *Wednesday* morning. I will repeat them exactly and then describe what he means.

"Sam and Percy. Go and open out those winter oats in the Stackyard Field. I'll send two women along later to tie up. Bill and George you two had better get the binders out. Put the canvasses on. Sharpen up the knives and then oil round. We're going to start cutting to-morrow."

Opening Out The Oats.

Firstly, what does he mean by "open out the oats?" Here is the answer. The corn is growing close up to the hedge. It would be impossible to take the machine that cuts the corn round the field without trampling down the growing corn unless a pathway had first been cleared for it. You will of course realize that this machine is pulled and not pushed. "Opening out" a corn field is simply mowing a roadway round the outside. This job is done by scything by hand. It is one of the few jobs left on a modern farm where the scythe is still necessary.

Sam and Percy arrive at the Stackyard Field with a scythe each. They give their blades a good sharpening for a start and off they go, one in each direction, from the corner of the field.

They cut a lane about 5 feet wide all round the field. We need not describe how they handle their scythes, that has been explained already. The corn they scythe falls in a swath and is of course loose, and that is why the two women are sent to tie up the loose corn into sheaves.

Tying Up.

There is quite a knack in tying up sheaves. First of all you pick up about half a dozen straws in each hand, you knot these together so that you have a straw rope about four feet long. Then you lay your straw rope on the ground, gather a good armful of the mown corn and place it on top of the straw rope. You must take care that all the ears of grain (usually called heads) are at one end whilst the bristly (cut) ends of the straw are at the other. Then you pick up the two ends of your straw rope (usually termed "band" or "bond") which stick out on either side of the armful of corn and pull them together—at the same time of course—enclosing the armful of corn. Next you twist these two ends round each other about three times, tuck in the twisted part and there is your sheaf: the ears of grain at one end, a straw "band" round the middle and the bristly parts of the cut corn at the other end. The term for the cut end is the "butt end." Having made the sheaf, the woman sets it up against the hedge in order to leave the mown lane clear for the cutting machine. Of course the "butt" of the sheaf rests on the ground and the "head" on the hedge.

The Binder.

And now let us pay a visit to Bill Lyon and George Green who are busy with the binder. A binder is simply a mechanical scyther and sheaf-maker. Incidentally it is one of the most ingenious machines ever invented.

Mr. Bishop's binders are drawn by tractors and they have a cutting width of 6 feet each. The expression "canvasses" refers to the apparatus which conveys the corn, after it is cut, to the sheaf-making machinery, the name "canvas" is used because of the material of which this part of the equipment is largely made.

On a well-run farm like this, the mechanical overhaul and replacements have been effected during the previous winter, but a thorough oiling after eleven months' idleness is of course necessary, and there is quite a lot of adjusting and

Stooking Corn

intricate transportation required before the binder is finally in the corn field all ready for work.

Preliminaries are finished. The great day is here. It is a beautiful morning, with hardly any dew. George Green starts the tractor off, Bill Lyon climbs on to his seat on the binder; Mr. Bishop says, "Don't leave too much stubble, Bill, we can do with all the straw we can get." A final shout from George, "Are you ready, Bill?" a wave of the hand from Bill and off they go. Harvest has begun.

Just look at the binder. The knife cuts the golden corn. The sails of the binder press the severed corn back on to the platform behind the knife bar. The canvasses carry the corn up to the sheaf-making apparatus where each sheaf is tied with string and ejected. In straightforward corn and with no mechanical breakdowns there is not much trouble in cutting an acre of corn an hour with a binder. Think of the grinding hard work it must have been when the job was done by hand.

When the binder has been round the field about a dozen times, six men arrive to "stook" the sheaves.

Stooking.

Stooking (sometimes called "shocking") is not a particularly expert job. If a person hasn't learned how to stook after a quarter of an hour's practice, he really must be a hopeless case as far as any manual work goes.

Oh—you want to know what stooking means and why it is done.

The binder ejects the sheaves on to the ground where they lie flat. There is still a certain amount of sap in the straw and very often the grain itself contains much moisture. Both the straw and the grain must be dry before the crop can be stacked. Thus the sheaves must be placed in a position where they will most easily become dry and where they are least likely to become damaged if the weather turns wet before they are stacked.

Here are two men stooking. If we watch them doing it, we shall soon understand it.

Each man is picking up a sheaf under each arm, the head of the sheaf in front of him, the butt behind him. By the way, when a sheaf has been made by a binder, the butt of the sheaf is not quite level at the bottom. In other words, the bottom of the sheaf slopes slightly. And when the sheaf is ejected it drops on the ground with the longer end of the butt uppermost. Thus when you pick it up and tuck it under your arm, the shorter end of the butt is next to your body.

Now, watch these men more carefully.

One of them walks to the place where the stook is to be made. He has a sheaf under each arm. He grasps the head of each sheaf with one hand, lifts his elbows and causes the butts of the sheaves to drop, one on each side of his feet. Before the sheaves touch the ground he gives a sharp thrust down with each hand and this thrust will make the butts hit the ground quite hard. The effect of this thrust makes the foundation quite firm and is easily the most important part of stooking.

As the butts of the sheaves come to the ground roughly 12 inches apart, the heads of the sheaves are touching each other, thus forming with the ground a triangle. The other man makes a similar triangle, touching the first pair of sheaves. More pairs of sheaves are added to these and the whole group is called a "stook" or a "shock."

It will now be obvious why the butts of the sheaves slope a little. If it is not obvious, I am going to leave it to you to work it out for yourself.

When a stook has been properly made, it is surprising how well it is able to remain standing after quite a strong wind. If ever you see a corn field where every alternate row of stooks has been blown down whilst the other rows are all right, you will know—after what I have said—that there have been good stookers and bad stookers at work in that field.

Five or seven *pairs* of sheaves to a stook is the ideal number. In any case, always have an odd number of *pairs*, not an even number; here is the reason: the first pair you stook should act as the

pivot of the stook; this pair should stand upright without any support. But however much you try to avoid it, there is always a tendency to make the remaining pairs of sheaves lean towards the first pair, which, of course, is the centre pair in the stook. Obviously, you cannot have an equal weight leaning towards the centre upright from each side unless the total number of pairs of sheaves is an odd number. And if a greater weight were leaning on the pivot from one side, the stook would probably fall down.

Another tip. Build the stooks with their ends open to the north and the south—not east, west. The north-south stook has its sides exposed to the east and to the west. One of the prevailing winds in this country is south-west, which can blow right through a stook from the side. In any case, the east side will get the morning sun and the west side the afternoon's rays, whereas the stook built pointing east-west will get no sun at all on the north side, and the prevailing wind will only catch the end of the stook, not the whole side.

In the days of horse-drawn binders, it was assumed that four men could stook up an average crop as quickly as the binder could cut it. But with modern sheaf-carriers and the greater capacity of the tractor-binder, such assumptions would be wide of the mark. It is most difficult to assess a fair day's work at stooking.

We have already mentioned that the first fields of corn to be cut on Mr. Bishop's farm were straight forward going. These have been finished and stooked up satisfactorily and now the difficult jobs begin.

" Laid " Corn.

There is a field of oats which has been badly " laid " by wind and rain. In places it looks as if a steam-roller has gone over it. Fortunately the corn has gone down in *one* direction, namely with the heads pointing to the north-east (it was a south-west wind that blew it down). In most places of the field, the actual ears of grain are not quite touching the ground, they are about three inches above it. If the binder travels in the same direction as that in which the corn is laid, it cannot cut it. The knife fingers cannot get under the corn and will simply go over the top of it without cutting it. But if the binder travels in the opposite direction, the fingers *can* get under the laid corn: they tend to raise it a little and the knives are able to catch most of it. In places where the corn may have been laid too flat for the knife to get under it, or where it has been twisted in all directions, a man goes along with a pole some five feet long and straightens it by hand, an operation technically known as " putting up."

At last all the corn is cut and stooked. Mr. Bishop breathes a great sigh of relief. He reckons that harvest is 75 per cent completed when this is done. I quite agree with him. In most seasons the bulk of the damage, both as far as quality and quantity are concerned, happens before the corn is cut.

You see—corn goes on ripening on dull, wet days just as it does on fine, dry days, and once the grain gets past a certain stage of ripeness, it automatically leaves the ear and falls onto the ground where it is lost as far as usefulness goes.

Once the corn is cut and properly stooked, it will stand a considerable amount of wet weather before it comes to any real harm.

Stacking.

The same principles for stacking corn apply as were noticed when we were considering the stacking of hay. The same golden rule " Keep the middle of the stack well filled all the way up " is also applicable.

The actual carrying of corn is rather different from that adopted with hay. There is at the moment no implement that can pick up the stooks and carry them bodily to the stack as a " sweep " does with hay. Thus the sheaves must be forked by hand on to wagons or carts and then transported to the stack either by horses or tractors.

The men who fork the sheaves on to the wagons in the field (" pitchers " in the south, " forkers in the field " in the north) are of course the pace-setters for the whole harvest gang. Those on the wagon who load it (the " loaders ") must be up to their job at loading or they will not be able to get anything like a decent quantity of corn onto the load and they must be able to load it up on the wagons so that it will not slip off as it travels on its way to the stack.

" Pitching."

A word about " pitching." You will notice that a pitching fork has two tines which curve slightly, and the points of the tines are sharp. Hold your fork in the prescribed way and stick the tines into the sheaf where the string is tied round it. Lift the sheaf on to the wagon and as you lift, turn the wrist of the hand that is nearer the end of the fork. This turn of your wrist will cause the sharp ends of the tines to point downwards. Then when you put the sheaf on the wagon you will find it quite easy to withdraw the fork from it.

If you do not turn your wrist two things may happen. Firstly, it may be difficult to withdraw the fork from the sheaf, and secondly, the loader on the wagon will not know that your fork is still stuck in the sheaf and may run a point of the tines into his hand as he picks up the sheaf before placing it in position on the load. Pricking another person's hand with a fork is rightly regarded as being " beyond the pale " in agricultural circles. Some very choice expressions will be forthcoming if you happen to be the guilty party.

Loading.

Loading! This is not a particularly difficult

task. Here are a few hints: the load is built in the same retangular shape as that of the wagon itself. The principles are roughly the same as those governing the making of a stack, though the care of keeping the middle filled up is not very essential. The main thing is to see that as you build up higher, the four sheaves at the four corners of the load are kept well out. There is a subconscious tendency to draw in the corners as you build higher. If you do, you will soon find the roof coming to a point in the middle with little more than half the required quantity of sheaves on the wagon, and there will be no chance of putting on any more sheaves with any hope that they will remain there without slipping off when the wagon moves forward.

By the way, I do not believe I have made it clear that when making a corn stack or loading a wagon, the sheaves on the outside of the load or stack are always placed with the butts to the outside and the heads to the inside of the stack or load.

Harvest Progresses.

And so harvest progresses. So long as the corn is dry, every moment of daylight is spent in carrying it. When is it dry? Some of the old sayings are a help. Here's one. "Oats should be in stook for three Sundays." In other words, oats ought to be left in stook for more than a fortnight so that the sap shall leave the straw and the moisture leave the grain. The best way to tell whether corn is fit for stacking is to thrust your hand into the middle of the sheaf where the string is tied (farming term, the "band" or "bond"). If that part is dry and feels quite crackly, pick up the sheaf and feel the butt which has been resting on the ground. Perhaps the butt may feel a bit damp whilst the rest of the sheaf is dry. Do not be tempted to stack corn in that condition. Quite possibly it will soon dry up if you pull the stooks over on their sides and allow the sun and wind to dry the butts.

Another old farming saying: "There's more corn spoilt in the stack than ever there is in the stook." This is very, very true. Never mind what the neighbours are doing, back your own judgment and if you do not think your corn is fit to stack, leave it a little longer in the stook. You will be far more frequently right than wrong if you follow this course; and it is not always the farm that finishes harvest first that has the best corn.

A Few More Hints.

Before closing down on this question of harvest, I add a few more hints. If the weather is exceptionally wet and warm and the corn has been in stook many weeks, the grain will begin to sprout whilst still in the stook. You can do one of two things to remedy this. Either move the stooks by hand onto a new foundation or build very small stacks with chimneys in them to let out the heat which is sure to be generated when damp corn is built up into a stack.

First, here is a method for moving the stooks. The easiest and quickest way to do this is to have

THATCHING

two poles about 7 feet long with iron spikes some 6 inches long spaced out at every foot along the poles. Two men hold these poles just as stretcher bearers hold a stretcher, although the men face each other for the purpose of stook lifting. They place a pole on each side of the stook, the spikes sticking inwards, then they close the poles onto the sheaves so that the spikes stick well in. Then there is a combined lift and the whole stook is then moved bodily to its new setting. Obviously you must not put too many sheaves in a stook if you anticipate having to move them later or the weight will be too much for the men to lift. Even in wet weather, the moving of the stooks seems to

make them drier and to stop the grain from sprouting; and this is something for which I am afraid I can give no satisfactory reason.

Second, chimneys in the stacks are useful. The reason is, of course, obvious and this is how to do it. Take a large-sized sack and fill it tightly with chaff or cavings. Set this sack upright in the middle of the bottom of the stack and build in the approved manner. As the height of the stack increases, simply pull the sack upwards. You will now see that where this sack has been there is an open space and there are no sheaves. You will thus have a " chimney " all the way up the stack. But be careful that you do not make a false step on the top of the stack and fall down the chimney. It would be a very difficult job to get you out again if you did.

At last the harvest is safely gathered in, much to everyone's relief, and the working hours on the farm revert to normal.

Thatching.

The corn stacks must now be thatched. Thatching simply means putting a cover of straw on the roof of a stack in such a way that the rain cannot enter the stack. If you look at the slates on the roof of a house you will find that each slate slightly overlaps the one below it, and this causes rain to run straight down to the eaves without getting into the roof of the house. Thatching is just the same.

The thatcher leans a long ladder against the stack about a yard from one end. He carries up a bundle of straw (wheat or rye straw) and put his first layer at the *bottom* of the roof in the space between the ladder and the end of the stack with the strands of the straw lying in a direction up and down the slope of the roof. The builder putting slates or tiles on a house begins in just the same way and you can regard this first layer of straw as the first " tile " on the roof. The next layer goes on a little higher up the roof but with a length of about 6 inches of the straw overlapping the top of the original layer. And so on to the crest of the roof. Obviously straw laid on in this fashion must be fastened down or the wind will simply blow it away. There are several ways of fastening it down. The first is by driving pointed wooden pegs some three feet long into the gable end of the roof at intervals of about a yard. String is tied to the end of these pegs and when the thatcher has put on his first layer of thatch, he simply pulls this string horizontally and tightly across the thatch and ties it to the end of the corresponding peg which is driven in to the roof some two or three feet inwards from the gable end on the edge of the layer of thatch. This process goes on over the whole of one side of the roof until this side is covered with thatch fastened down by the string tied to the pegs. Then the other side of the roof is thatched in the same manner.

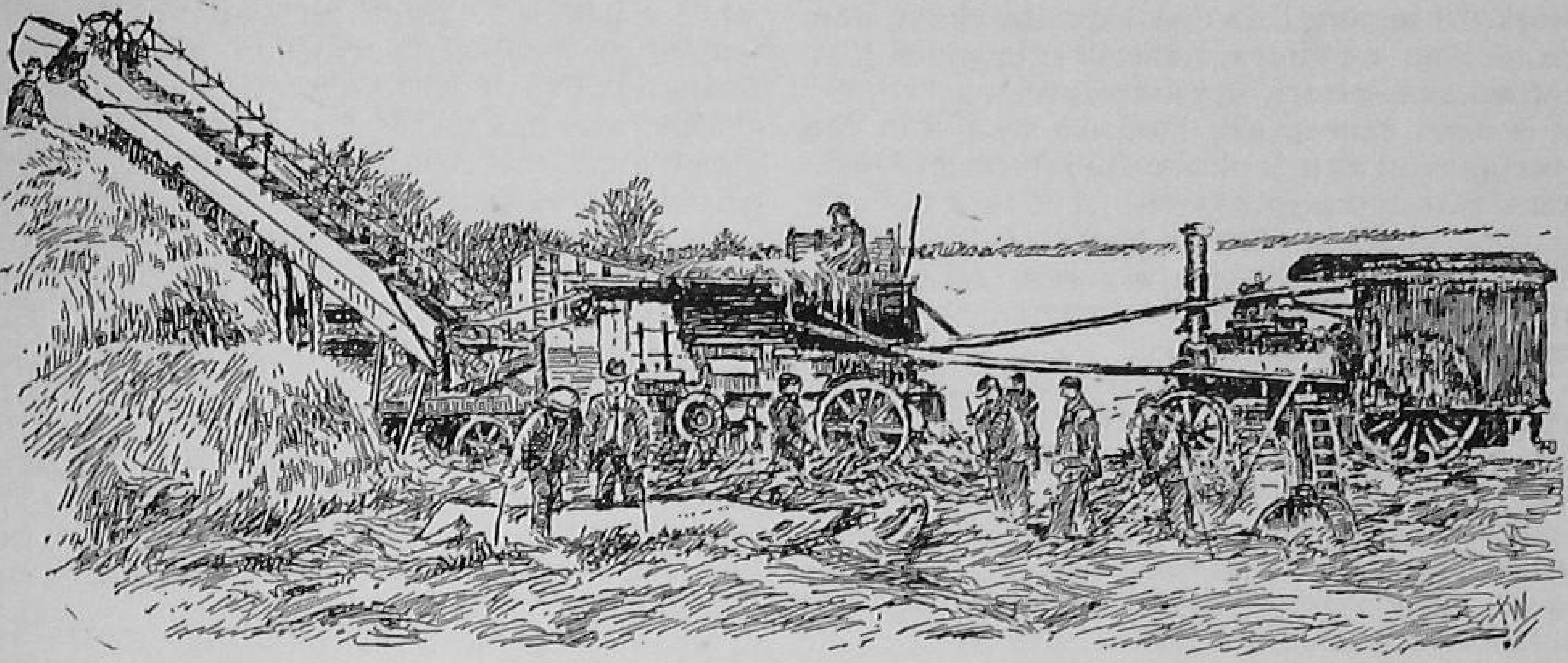
Another way of keeping the thatch in place can be effected without the use of the pegs and string. The actual thatch is put on in the same way, that is, in strips, but with this difference, both sides of the roof are covered at the same time. The thatch is held in position by covering the whole roof by a large net which is unrolled over the thatch as it is laid on. Later, this net is weighted down by tying large poles or other heavy objects to it. The advantage of this method really lies in the great saving of time in doing the job as compared to the peg and string method.

" How do skilled men manage to put on thatch until they have a beautifully neat surface with not a straw out of place? " you may ask.

There are several answers to this:

Firstly, the straw to be used as thatch has been carefully straightened by hand before it was carried on to the roof. This straightening of the straw is usually termed " drawing straw for thatch." Then it has been put in position on the roof very carefully, and your skilled hand has combed it down with a small hand-rake after it has been laid. All this takes time—a very valuable commodity in these days.

One hears it said that thatching is a dying art. I do not think that that is literally true. You do not see the neat thatching nowadays, but I think the men of to-day can make a stack waterproof just as well as their fathers did, even if the result is not quite so tidy. After all, putting on thatch which will keep the stack dry is not such an intricate job as some people make it out to be.



THRESHING CORN

THRESHING AND OTHER MATTERS

The threshing machine ingeniously grades the grain, but its presence on the farm inspires a little agricultural wit and sets the engineers a few problems! Threshing is not very popular with the workers, for dust and fine chaff cause much discomfort. Details of operations comprised in threshing corn is mentioned and many of them are thoroughly explained. " How much does the team of fourteen thresh in a day? " An average of 20 cwt. of grain per hour would be really good. . . . Other matters are considered in this section —the Potato harvest—storing potatoes—the Mangold harvest—gathering in the Sugar-beet. In his closing words our author points out the importance of regarding the whole farm as a unit in which everyone is ready to take on any necessary duty for the good of the farm as a whole. Mr. Bishop can do all the jobs on the farm, he knows their difficulties and he has that priceless gift—a sense of humour. And so we say farewell to Hardwell Grange, Biggenden, and to " the governor " and his men.

MR. BISHOP has no threshing machine of his own. He does what most farmers do, hires one. Arrangements having been made with the proprietor of the threshing machine, frequently termed the " drum " and facetiously known as " the relieving officer," the day arrives for the corn to be threshed.

Threshing Machine.

A threshing machine is described by its name. It threshes the grain from the stems, winnows the chaff from the grain, ties up the threshed straw into bundles (in Yorkshire " loggins ") and by means of an ingenious device divides the grain into three grades—best (or fore-ends), medium and poor, colloquially termed " tail " or " hinder-ends " (Kent and Yorkshire expressions respectively).

There is usually a funny man on the staff of a large farm. Mr. Bishop's staff is no exception. The comedian on this farm thinks that threshing machines should be improved on the following lines: When wheat is threshed, loaves of bread should come out of one end of the machine and straw hats from the other or, in the case of barley, barrels of beer and shopping baskets and in the case of oats, porridge and rolls of paper. Well—there's an idea for the agricultural engineers!

However, let us get back to the actual threshing; it is not a very popular job on a farm. What with the dust and little pieces of chaff down your neck and in your eyes, I suppose that most of us on the land are delighted when the machine leaves the farm.

This particular machine is driven by a steam engine, though a powerful tractor will do just as well. The actual setting of the drum alongside the corn stack and the care of the machinery itself rest with the two men in charge, the driver and the feeder. Coal and water to feed the steam engine have been provided by Mr. Bishop. It is 7 a.m. Everything is ready. Two men, each with a fork, get on to the corn stack to pitch the sheaves of corn on to the top of the machine. These two men are the pacemakers and must naturally be adepts in handling a fork and must understand their job, which is not as simple as it looks—but more of that later.

The Feeder.

On the top of the machine are the feeder and the " band "- or " bond "-cutter. You remember, of course, that the sheaves are tied with string. Well, the " band "-cutter picks up the sheaves as they are passed to him from the stack, cuts the string and passes the loose corn to the feeder. The latter feeds the machine, that is, he drops the loose sheaf into the open slot below which

work the beaters, long metal bars revolving very quickly on a cylinder. The description of this job makes it sound a very simple one. In practice it is not. You do not drop the sheaf into the machine just as it is, if you did you might break some part of the mechanism. You have to open out the sheaf and allow it to drop in gradually. Furthermore, you must have your next sheaf ready at once so that there is a continuous trickle of corn going in.

The next time you come across a threshing machine at work listen to the hum it makes. If the noise of this hum is a continuous even note, then the feeder is doing his job properly. If the noise varies in key from a low roar to quite a high pitched note, you will then know that the feeder is at times overloading the machine, and at others is putting nothing at all into it. This is very bad feeding.

On the ground are the rest of the threshing team. The two strongest men on the farm are taking off the sacks of corn as they are filled, weighing them up in the required weights and carrying them off to the barn for storage. Whilst strength is most certainly needed to carry a sack of wheat weighing 2¼ cwt., there is a certain amount of knack in it, a knack which can only be acquired by experience.

At the side of the machine are two boys who carry away the chaff and cavings in large sheets made of sacking. Then there are four men to handle the straw; one to stack it in a fresh place, and the other three to take it away from the machine and pass it on to the straw stacker. Later in the day, when the corn stack has been reduced below the level of the top of the machine another man will be sent to help pitch the sheaves.

And now a word about this job of pitching the sheaves. The sheaves must be picked up in exactly the reverse order from that in which they were placed when the stack was built. "Why?" you may ask. "You will remember that the sheaves were laid overlapping each other when the stack was made. Well—if you try to pick up a sheaf which is still partly pinned down by another sheaf, you are simply making extra unnecessary work. And if ever you start picking up sheaves at random as you are lowering a corn stack, you will soon reach the stage when every sheaf you see appears to be pinned down by another. You *must* stick to the proper sequence. Still, an hour's practice is the best training. If you ever try this job and get into a muddle, but are left to disentangle it yourself, you will have a lesson you will not forget in a hurry."

How Much in a Day?

Mathematicians will by now have noticed that, including the driver and feeder, fourteen hands are engaged on threshing at Mr. Bishop's farm. The leading question is—how much do they thresh in a day? All kinds of answers are given to this.

For my part, the most that I have ever seen threshed is 92 quarters of barley in ten hours, roughly 37 cwt. of grain per hour. But I have also seen as little as 9 cwt. an hour threshed when everyone was working just as hard as on the former occasion. In my opinion, an average of 20 cwt. of grain threshed per hour is one which would take a lot of beating over a period of years, if one includes the time spent in moving the machine from one stack to another.

And so, we thankfully say "Good-bye" to the threshing machine, have a good wash and a little refreshment at the "Brown Cow" to fortify ourselves for another kind of harvest, that of the potato crop.

The Potato Harvest.

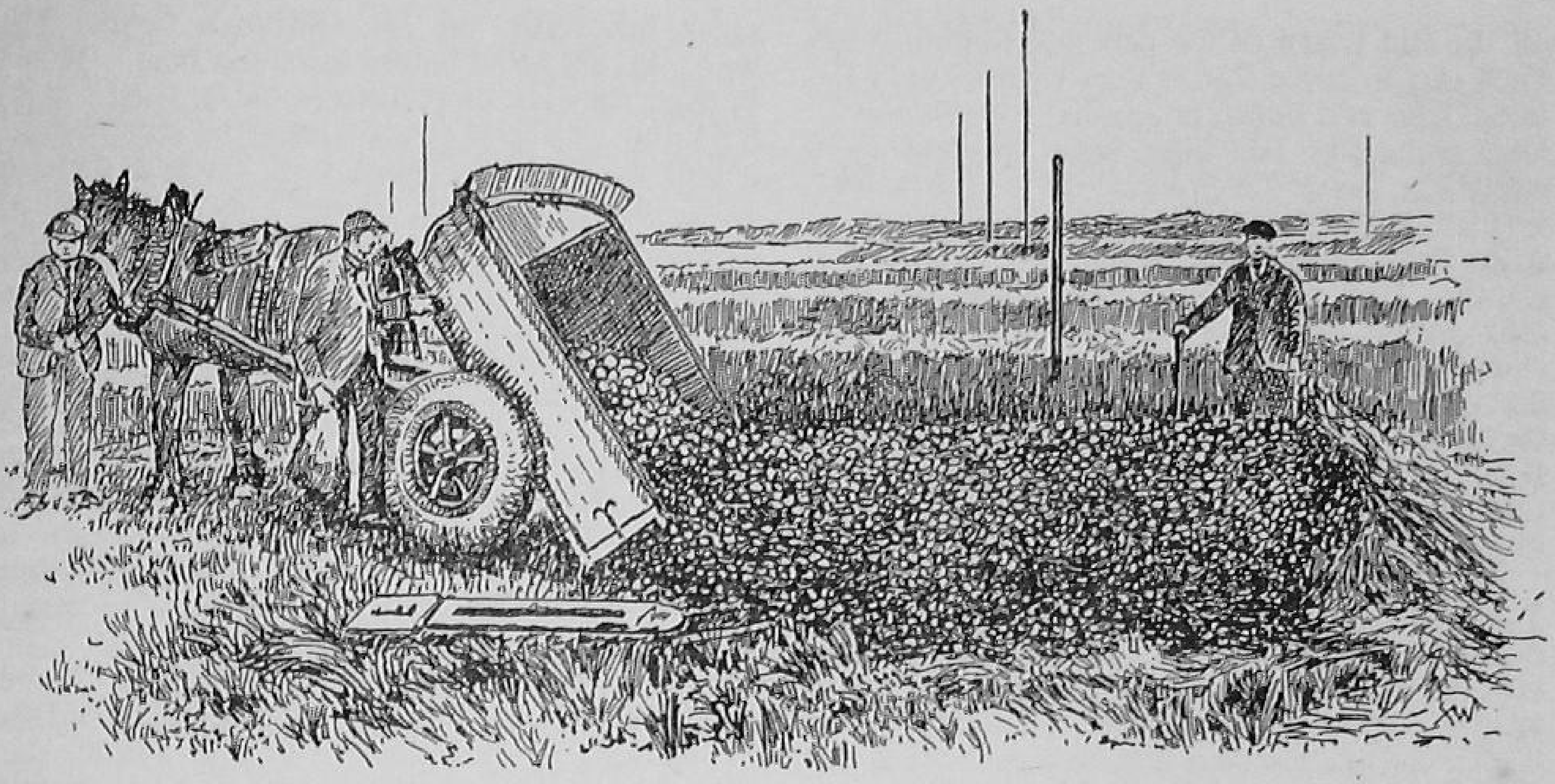
You will remember that the last work we described concerning the potato crop was the "soiling-up," generally called the "earthing-up," of the rows. Thus the first job in the potato harvest is to get the tubers out of the soil and onto the surface.

There are several ways of doing this: (1) by hand with a potato fork; (2) by a special plough (horse-drawn) which throws most of the potatoes onto the top of the soil; and (3) by an implement called a potato spinner which can be pulled by horses or by a tractor. A spinner is described by its name; it has either one or two revolving wheels with long iron fingers attached at intervals to the rim of the wheel (or wheels). As the wheel revolves, the fingers "spin out" the potatoes from the potato row and leave most of them on the top of the ground.

Let us look at the actual job. Hand-forking is fairly straightforward. You simply dig up a row of potatoes, pick them up by hand into buckets or baskets, and empty them into a cart that travels along with you. If you are short of horses and carts, you empty your buckets into sacks which must be laid out at intervals along the potato row. When the sacks are full of potatoes, they must be collected and taken to the place of storage. You can, of course, get on with the job very much quicker if you have sufficient horses and carts, as their employment obviously saves a great deal of handling of the potatoes.

Potato Plough.

If you propose to use a potato plough, the job is rather different. You plough up every alternate row and the pickers go up these rows on their hands and knees. A plough, as I have said, will not throw all the potatoes to the surface, but will leave quite a large proportion just under the soil, so that the pickers must scratch the soil with their hands to find the hidden tubers, hence the north-country expression of "'tatie scrattin," as applied to this particular job. Incidentally, this method of lifting the potato crop is gradually becoming obsolete.



Clamping Potatoes

Finally, the potato crop spinner. Most spinners throw out the potatoes to the right side of the machine, consequently you cannot spin out one row and come back down the next row. If you did you would be spinning out the potatoes among the rows which have not been touched and there they would be rather difficult to find and pick up. If you remember the way ploughing is done, the Yorkshire expression of "gees" and "arves" describes it, you will see that potato spinning must be done in the same way in order to make the machine throw out the potatoes onto the land which has already been cleared. There is, however, this difference. When you plough round a strip of land, you are gradually making that strip larger, whereas when you spin out potatoes, the strip gradually becomes smaller.

How much can be done in a day? I once remember seeing nine men pick up 36 tons of potatoes in nine hours. They were Irishmen working on piece rates, and they were specialists at the job. The crop was a heavy one, the going was good and there were plenty of horses and carts to take away the potatoes. But I must admit that I never seen any other men anywhere keep working at such a speed for a whole day. I have not seen any statistics published about potato lifting, but I should say that with an average crop of potatoes, it would be a fair day's work if a man picked up two tons. And he would not do as much as that if he had to empty his bucket into sacks instead of into a cart.

It is not much use harvesting potatoes well if they are not stored properly afterwards, and it is no use starting to store them until they are ripe. "How can you tell this?" "Quite simply. Pick up a potato in each hand, rub them together and look at the skins of the potatoes. If the skin peels in the least, the potato is not ripe and will probably go bad if you store it. The skin must not show any signs of damage after rubbing. The haulm has usually already died when a potato is ripe, but not always. The haulm may still be green yet the tubers are ripe. In any case, you won't have any more growth in the crop once it is ripe, so you might just as well get on with harvesting it, there's no point in waiting."

Storing Potatoes.

Now there are two points to be remembered about storing potatoes. Firstly, they must be kept in the dark; light will turn them green and make them unfit for human consumption. Secondly, they must be made secure from frost. The potato is extremely susceptible to frost. One or two degrees of frost will make it go rotten.

A visit to Mr. Bishop's farm will show us how potatoes are stored. We find a man making ready the ground on which the potato "clamp" or "pie" will stand. He has a spade and is taking off a thin paring of soil, about ½ an inch thick, from a strip about seven feet wide. "Why does he do that?" you ask. "So that there is a smooth surface for the potatoes to rest on. If you have an uneven surface a lot of potatoes will be cut by the potato shovels, technically called "potato scoops" or "sippets," when the tubers are being shovelled out of the clamp during the winter."

Another man is making long wisps of straw (wheat or rye is the best) and is placing these wisps along each side of the bottom of the clamp. Here come the carts full of potatoes. The first one is driven to the site of the clamp, turned round at the end of the site and the potatoes are shot out into a heap by the simple expedient of taking

off the end board of the cart and tipping it up. Each cart in succession is then backed up to the initial heap and tipped up, so that we soon have a heap about four feet high, seven feet wide, and stretching along the ground where it has been levelled out. You will now see why wisps of straw have been placed along each side of the clamp. They not only act as a mark, but they also prevent the potatoes on the edge of the clamp from rolling outwards. Of course a few do roll outwards when the cart is tipped up and these are put back onto the heap by hand. Incidentally this heap comes to a point at the top. In cross-section the heap is rather triangular in fact.

After the clamp has reached a length of about 5 or 6 yards, it is covered with straw. I do not mean that straw is thrown on to it haphazard, very far from it. A truss of tied straw is placed against the side of the clamp, the string of the truss is cut, and the truss is opened out so that the straw lies about six inches thick on the potatoes. If you look closely you will notice that the appearance of the straw on the potatoes is rather like the thatch on a stack. More straw is then laid on the crest of the clamp, the trusses of straw being laid across the clamp and not lengthways. Then a layer of soil is thrown on to the places where the ends of the trusses are, that is, at the bottom of the clamp and about a foot from the crest of the clamp.

Ventilation.

When the potatoes are put into a heap like this, a certain amount of heat is generated and this heat must be allowed to escape or the potatoes will go bad. After being left for about three weeks with a covering of straw only, the clamps are then completely covered with soil about 4 inches thick, though small vent holes along the top of the clamp every 2 yards provide ventilation. It is quite easy to make these vent holes. When you are soiling up the clamp for the last time you stick a small wisp of straw, 6 inches long and 6 inches in circumference upright on the top of the clamp. Put your soil all round this wisp of straw but leave the end sticking out of the clamp; you will thus have a small chimney made of straw, and this will give all the necessary ventilation. Strangely enough, the covering of straw in the potato clamp will not keep out frost if used by itself, nor would the covering of soil alone provide the protection. It is the combination of the two which does the trick.

Either the north or east side of a potato clamp according to the directions of the lay-out of the clamp is more liable to catch the frost than the opposite side, south or west respectively. Therefore, if you are rather late in the season in soiling up, do the north (or east) side first.

We are getting towards the end of the harvesting of crops on the usual type of mixed farm in England. There are still mangold crop and the sugar beet crop on Mr. Bishop's farm. The mangolds are lifted before the sugar beet. Why? Because they are more susceptible to frost. I do not know why frost sends a mangold rotten while it will thaw out of swedes or turnips without doing much damage, though there must, of course, be a scientific reason for it.

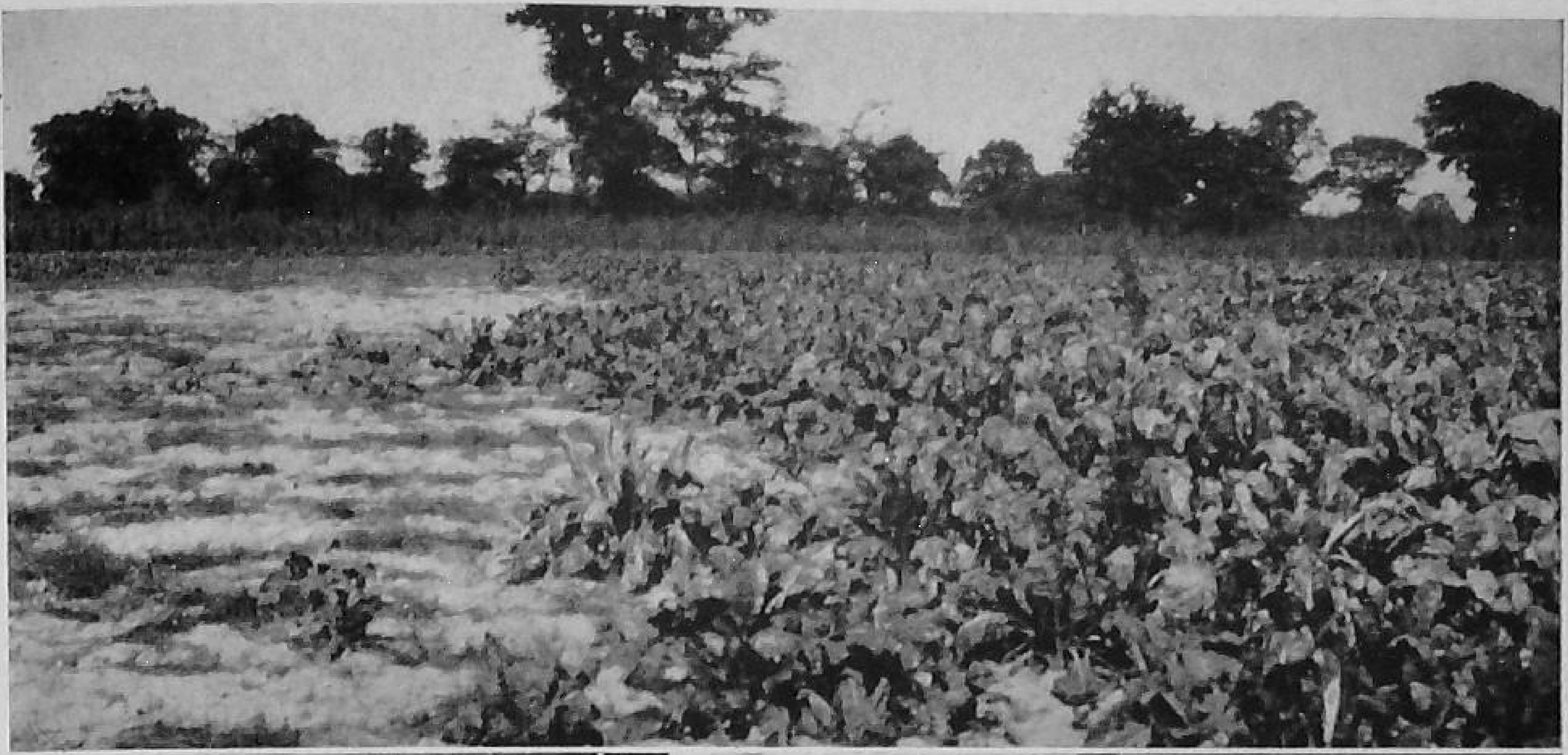
Mangold Harvesting.

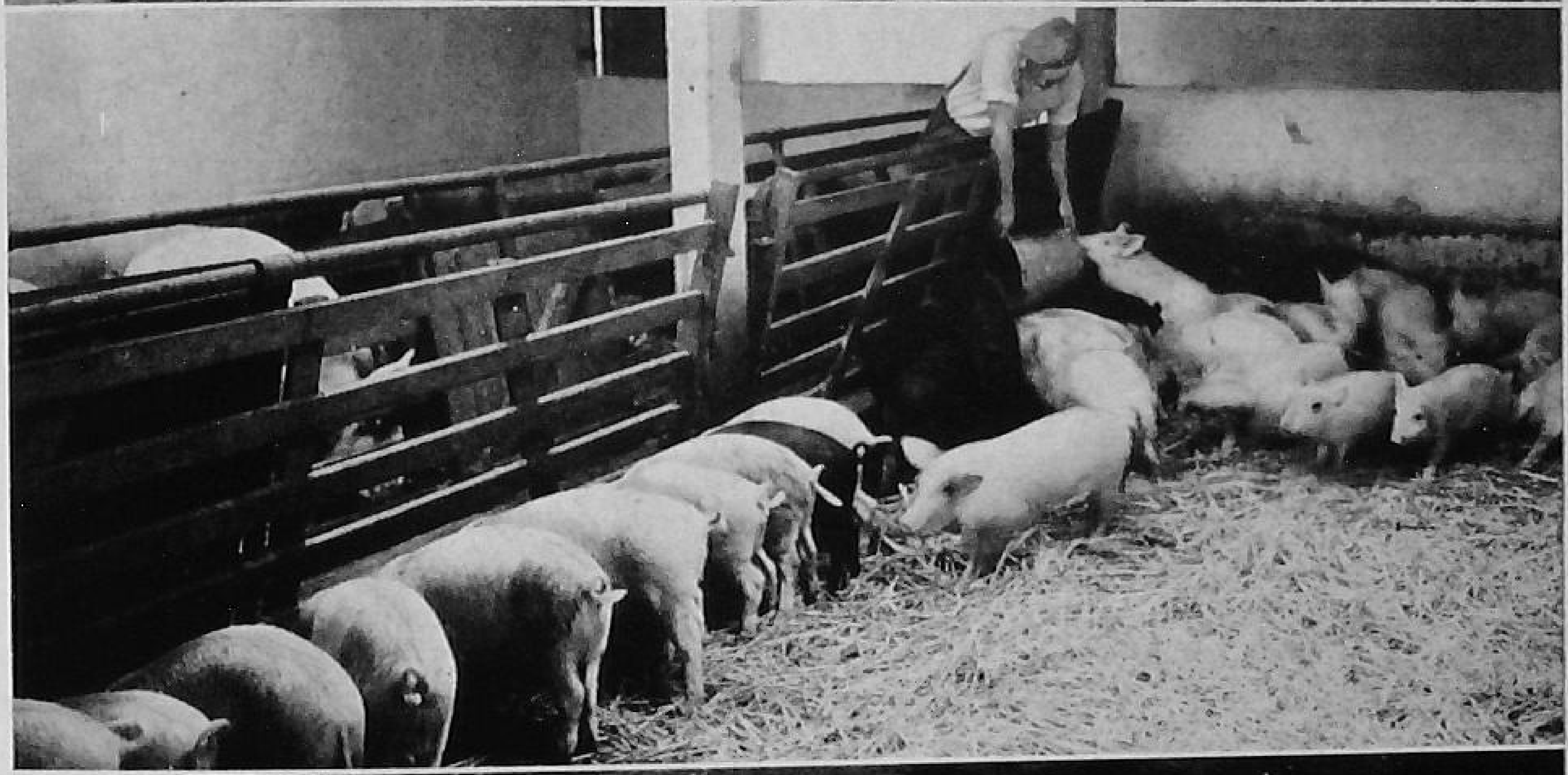
About mangold harvesting there is not much to be said. The mangolds must first be pulled out of the ground. This is done by hand. Get hold of the mangold leaves with one hand, give a pull and the whole plant comes out of the ground quite easily. In the other hand you have a knife. Cut off the leaves close to their junction with the bulb. The only care needed is to avoid cutting your own fingers as you do this. The severed root then drops to the ground. There are differences in different parts of England in the subsequent procedure. In the south, the mangolds are thrown into little heaps and covered by the mangold leaves. In the north they are left on the ground in the place where they drop; the practice there is to make one row of lifted mangolds out of four rows of growing ones and that is quite easily done by holding the root exactly over the spot where you want it before you cut the leaves off. For my part, I prefer the north country method, it saves so much extra handling and unless it is very late in the season and hard frost is to be expected, the covering of leaves should not be necessary.

After "pulling," the mangolds are carted off the field and "clamped." They must be thrown by hand into the cart and not forked in, or at the place where the fork sticks in decay will begin, and after a few weeks the whole root will have rotted. The mangold clamp is very much larger than the potato clamp, in fact you can make a square one if you like and have a flat top. Cover with straw and later with soil if the clamp is not in a sheltered position and be sure to leave ventilation holes in the top. Its height can be 10 or 12 feet if you wish.

Sugar Beet.

And now, the sugar beet harvest. Not the least of the snags in lifting this crop is the fact that it is too firmly embedded in the ground to be pulled out by hand. A special sugar beet plough, drawn by two horses, is the first implement to be used when Mr. Bishop starts harvesting the crop. The principle of this plough can be briefly described as follows: the framework is practically the same as that of an ordinary plough; fixed to the beam of the plough is a long thin piece of metal, about 2 feet long, 3 or 4 inches wide and perhaps ¼ of an inch thick; this piece of metal is sharp on one edge and is fixed to the beam in such a manner that the sharp edge points forward in the direction in which the plough will travel. At the bottom of this metal bar and on one side





TUNSTALL EXPERIMENTAL STATION. (*Top*): EFFECT OF CHALK. THE LAND TO THE LEFT HAS NO CHALK; THAT TO THE RIGHT HAD 8 TONS OF CHALK TO THE ACRE 15 YEARS BEFORE
Photo: Courtesy A. W. Oldershaw, M.B.E.

GREEDY PIGS NEED AMPLE FEEDING-SPACE

PICKING PEAS: " ONE OF THE MOST DELIGHTFUL JOBS IN FARMING "
Farmer & Stockbreeder Photographs.

Above: THE BINDER: TEN JOBS COMBINED IN ONE
Below: STOOKING OR SHOCKING: A SHEAF UNDER EACH ARM

Farmer & Stockbreeder Photographs.

of it, is fixed the share, another piece of metal about a foot long, 3 inches wide and 2 inches thick, tapering at one end to a sharp edge. This share is attached at an angle of some 30 degrees with the sharp edge in front and at the bottom of the slope.

Now, if you can picture the tool, the description of how it works is fairly simple. The plough is adjusted until the bottom or sharp end of the share is running along about a foot below the ground level and just below the sugar beet roots. The upward slope of the share forces the sugar beet, and the soil round it, upwards, loosens it and makes it quite easy to pull out by hand. The vertical bar on the plough runs, of course, alongside the beet row in the ground and does not cut the roots because the share is fixed at one side and not directly underneath.

Here is Bill Lyon with the beet plough drawn by Doctor and Prince. He will plough up beet for a couple of days before the actual lifting starts and if the going is good, he will cover 2 to 3 acres a day. The reason for leaving the beet a couple of days after ploughing-up is to give the soil sticking to the roots a chance of drying. Wet soil cannot be shaken off very easily. The sugar factory does not want soil. Mr. Bishop does not want to pay a haulage charge for sending soil to the factory, which he is doing if the beet is in a dirty state. In fact, everything possible must be done to send away clean beet.

Beet Lifters.

When the beet lifters start work, they pick up the roots, one in each hand by the leaves, bang them together to knock off as much soil as possible and lay them on the ground in rows. Later they cut off the tops (i.e. the leaves and the top inch of the actual root) and throw them into small heaps. Later still the beet is thrown into wagons or carts and sent to the nearest railway station or reloaded onto motor lorries which take the crop to the sugar factory; it is rather a slow, laborious job, and quite a battle against time and frost. In a wet season, it may even be the New Year before the job is finished.

. . . .

There it is—we have pretty well been round the farming year and we have seen something of most of the important jobs on a mixed farm in this country.

. . . .

A Peculiarity.

All industries have their craftsmen and their specialists, but agriculture is distinguished by a peculiarity in this matter. In so many walks of life the specialist sticks to his own job and has little interest in any other. This is not the case in farming. Here are some examples of what I mean.

George Green is ploughing with his tractor. Two fields away are the sheep. He sees one of the sheep on its back. It cannot get up. Does he think, " Oh—that's Ned's job, let it stay where it is until Ned comes," or " My job is tractors, I've no responsibility for sheep. I'm doing nothing? "

Of course he does not. He would be looked upon as a pretty poor type of fellow, if he did. Then what does he do? Stops the tractor, goes over to the sheep and puts it back on its feet at once.

The Farm as a Whole.

Or again. It is harvest time and the weather is unsettled. Work must go on till dark. Does Jack Sharp say, " Not for me. I'm head cowman here. Harvest is no concern of mine." Rather not. He turns out after tea with everyone else. Mr. Bishop does not even have to ask him to help. In fact, it would not enter the head of either of them that there was any question of his turning out.

In short, a farm is a unit which cannot easily be sub-divided into water-tight compartments. It is the farm as a whole that counts.

Generally, throughout this book, we have dwelt principally upon the good craftsmanship of the farm workers. The farmer himself is entitled to a small niche under the same general heading. It may be that in a ploughing match Bill Lyon would beat Mr. Bishop. Ned Trumper might shear a sheep more quickly than the governor could, Jack Sharpe can perhaps milk a cow a bit better than his master can, and so on with all the men. After all, *the final skilled touch is only acquired after years of actual practice*, and Mr. Bishop does not get much practice at these jobs nowadays. But the point is that he *can* do *all* these jobs, and he knows the difficulties connected with them. His good craftsmanship rather lies in his ability to make up his mind quickly and correctly (a very important point that) when sudden decisions have to be made and in knowing what is exactly the right moment for any job to be started. Above all he has that priceless gift—a sense of humour.

SECTION III

GOOD FARM CROPS

by

A. W. OLDERSHAW
M.B.E., B.Sc., N.D.A.

Illustrations by

AGNES OLDERSHAW

INTRODUCTORY NOTE

DURING the past 100 years it has been the fashion in certain quarters, except during wars, to decry our efforts at food production. Foolish people, as well as those not wholly disinterested, have explained that Britain is not a corn-growing country, and that anyway, it is a sounder policy to import our food in exchange for manufactured goods. This ignores three fundamental facts:—

(1st) That Britain is a country admirably adapted for corn-production over a considerable portion of its area and is capable of producing as heavy crops as are obtained in any part of the world. Those regions of Wales, the Lake District, the Pennine Chain, and the Highlands of Scotland, with a heavy rainfall, though not well suited for corn, are often admirably fitted for the growth of such food crops as potatoes, roots, vegetables and grass. Green crops to be used as food for stock also usually succeed well in such districts.

(2nd) That the rural districts provide a simple healthy and natural life for those living there, and that it is very important from the point of view of the future of the nation that a hardy and healthy race should be maintained upon the land.

(3rd) That, as has been evident from the experiences of 1914–1918, and from 1939–45, in time of war it may be difficult or impossible to import the food supplies needed by our population. There are many other important reasons which we have not space to discuss here, for maintaining our home food production at a high level. Personally, I have no doubt whatever, in spite of statements to the contrary, that Britain could feed herself if she wished to do so. It is sufficient to say, however, that if my treatment of farm crops succeeds in increasing the interest taken in this great subject, its object will have been attained.

This section written for all who desire further knowledge on the subject, and, of necessity, it mentions many things well known to those brought up on the land. It is hoped, however, that it may be of use to those who already know something about our crops, as well as to those who, through lack of opportunity, have very little acquaintance with the means whereby man obtains his daily bread. To these latter I would say—you are not likely to regret trying to obtain as much information as you can about one of the primary physical needs of man. It is unfortunately the case that during the past century, agriculture has been hopelessly neglected in this country, except during great wars when we were in danger of starvation. But that does not alter the fact that of two great necessities of man—food and raiment—food is the more immediately urgent, and that none are performing a greater service to their country than those whose efforts provide us with our daily bread.

Of the farmer it is written—

> " He giveth his mind to make furrows and is diligent to give the kine fodder . . . He shall maintain the state of the world."
>
> *Ecclesiasticus* xxxviii. 26.

The author wishes to express his thanks to his wife for much assistance with the text and to his daughter, Agnes, who made the sketches for all the illustrations.

Harvesting Lucerne Hay on Blow-away Sand in East Anglia.

THE COURSE OF PROGRESS

Several preliminary matters are discussed in this first section. It is shewn that the improvement in farm implements during the past century and the application to agriculture of the findings of science have both helped food production very considerably. The subject of crop rotation receives attention. The lack of uniformity over the whole country in the use of weights and measures is deplored and the assumed weights per bushel for the common grains are given. The use of smaller sacks is progressive because it avoids strain and injury to the farm workers who have to handle the grain.

"If it had not been for the farmer we should have been starved—we should indeed have lost the war."—*Lord Woolton, in the House of Lords, February* 1943.

How Modern Inventions have Helped in the Production of Food.

Modern Inventions.

Farming is a very ancient industry—perhaps the most ancient of all except hunting. Even in this country arable agriculture has a written history of two thousand years, and it was probably old when Cæsar wrote of it. Hence there is an immense volume of practical tradition, and this has been handed down from father to son for many generations. During the past hundred years, however, remarkable progress has been made in improving farm implements and in applying modern science to Agriculture.

During the Victorian era, there was very rapid progress in the design of farm implements. Better ploughs were introduced, the sickle and scythe gave place first to the back delivery reaper and afterwards to the binder. Steam ploughs and cultivators came to the fore, and, at the same time, the flail, went out of use, and its place was taken by the modern threshing machine. More recently combine drills and harvesters have come in.

Since the introduction of the internal combustion engine, the use of powerful tractors has extended all over the land, and this has enabled man to produce very much more food than was the case when horses and oxen were the only aids to manual labour in cultivating the soil. The application of the sciences—Chemistry, Botany and Zoology especially—has helped greatly to increase our crops. The work of the agricultural chemist led to the introduction of so-called "artificial" manures. The famous experimental station founded by Sir John Lawes at Rothamsted in Hertfordshire in 1842, laid the foundation of our knowledge on this subject.

Agricultural Botany has led to the breeding or selection of greatly improved varieties of cultivated plants, and there is every reason to believe that further improved varieties may be introduced in the future.

The agricultural botanist has also helped greatly in the fight against fungous pests: rust in wheat, potato blight, and many others which do

an immense amount of harm and greatly reduce crops in certain seasons. The student of insect pests has placed at the farmer's disposal the means of checking the ravages of many harmful insects. All these things have put an entirely different aspect upon methods of food production. What was impossible owing to lack of tools and knowledge a hundred years ago, is now not only *possible* but *commonplace.*

There is no reason whatever why our little island should not become vastly more productive than ever before in its long history.

The work done by War Agricultural Executive Committees and by many private individuals in the years 1939–45 in bringing into cultivation land never cultivated before has shown that with modern implements and modern science, most unpromising land can often be made to grow good crops—sometimes with relatively little expenditure of labour. Valuable publications of the Ministry of Agriculture greatly aid farmers.

Rotation of Crops.

As a general rule both farmers and gardeners find it better to grow one crop after another, rather than to grow the same crop on the same land continuously. It is true that potatoes are often grown in gardens year after year; whilst Rothamsted experiments, in which wheat has been grown on the same land for a hundred years, show what can be done. But although such a proceeding is possible with wheat and with some other crops it is apparently impossible in our present state of knowledge, with certain other crops. Sir John Lawes failed to grow beans many years in succession. It is common knowledge that peas, clover, cruciferous plants and sugar beet should not be grown on the same land too often. The chief reason for this is that parasitic diseases are very apt to attack crops grown on the same land year after year. Also the growing plant takes certain plant foods from the soil. Different crops differ widely in the quantity of any particular plant food which they remove. It is also worthy of note that when such a crop as wheat, which usually occupies the land for ten months, is grown year after year on the same land, very little time is available between the removal of one crop and the planting of the next. This means that any cultivation must be brief, and there is little opportunity for killing weeds and " cleaning " the land.

It has also been found that one great family of plants, the Leguminosæ or Pod-bearers, enrich the land in nitrogen, one of the most important plant foods. This enrichment is of great value to succeeding crops. For these and other reasons our ancestors devised the excellent system of growing crops *in rotation*, the simplest rotation being:—

1st year—Roots and green crops (turnips, swedes, mangolds, sugar beet and allied crops; also cabbage and its allies).

2nd year—A spring sown cereal crop (barley, oats, or spring wheat).

3rd year—A leguminous crop (beans, peas, clover and similar crops).

4th year—Wheat, rye or other cereal.

This simple rotation is capable of many modifications, and most, if not all, rotations are based upon its general principles.

Taking the items one by one—

(1) *Roots and green crops.*

A large variety of plants is grown in the root shift. This may include (*a*) the *true* " *roots,*" such as swedes, turnips, mangolds, sugar beet, parsnips and carrots; (*b*) various crops of the *cruciferous family*, grown for consumption by animals or human beings. These plants include cabbages, kales, and kohl rabi; (*c*) *green crops*, such as maize; (*d*) *potatoes.*

The root shift or " break " as it is often called, usually affords a good opportunity of cleaning the land. It frequently follows a cereal which is removed in August or September. As the crops above mentioned are not planted until spring, often not until mid-April or even later, the land is unoccupied all the winter months. A certain amount of cultivation of the land may be done in autumn—in favourable years, a good deal—whilst in a dry spring further cleaning and tillage may be carried out before the crop is planted. The *amount* of cleaning possible depends largely upon the season. As a rule in the south of England there is a much better chance of cleaning the land in autumn than in northern Britain generally. After a late harvest, and a wet autumn, especially on heavy and sticky soil, the opportunity of cleaning may be small, even in southern England. On light or sandy soil, which may be ploughed two or three times between harvest and root planting, much cleaning may be done in this period. It is most important to realize that the cultivations desirable on heavy soil are very different from those on light soil. A heavy soil should receive its final ploughing for a spring crop before January 1st if possible. This gives time for the frosts of January and February to break down the soil and produce a *winter tilth*, or *mould*, which is very favourable for the growth of practically all crops.

(2) *Spring-sown cereal crop.*

As a rule, roots and green crops are followed by a spring-sown cereal crop. Very often swedes, turnips, kale, etc., are not removed from the land in time to grow an autumn-sown crop. In the case of potatoes, mangolds, and to a lesser extent sugar beet, removal is earlier, and these may be followed by autumn-sown wheat, oats, or barley. After the root shift, all the cultivation usually necessary until seeding time is one ploughing

which, in the case of heavy land, should be done before January 1st, wherever possible. On light land, ploughing may take place immediately before drilling the cereal. Usually, however, it is best to get the ploughing done in good time, and whenever the weather is favourable. Even light land is best left untouched during a period of wet weather. A very common way of extending the rotation is to grow two cereal crops, one after the other, after roots. The second crop in this case usually needs a good dressing of artificial or chemical manures.

(3) *Leguminous crops.*
This may consist of beans, peas, lupins (on very light land), clover, or the mixture of clovers and grasses which is commonly called " seeds " in certain parts of England.

The cultivation of the land for beans or peas after the previous cereal is removed is very simple. An autumn cleaning is given whenever the weather permits, followed by ploughing.

Clover and " seeds " are drilled or sown in the preceding cereal in the spring. When the cereal is removed at harvest the small plants of clover and grass persist and give a crop the next year.

In some parts of the British Isles, especially in Scotland and Ireland, the clover and grass seed mixtures are left down for two, three or more years, thus lengthening the rotation. This practice is extending to other parts of the country, and it is proposed to discuss it further when dealing with clover and rotation grass.

Where red clover is grown alone without any grass mixed with it, this shift of the rotation only lasts one year.

(4) *Wheat or other cereal.*
In districts suitable for wheat growing, it is that cereal which usually follows the leguminous crop in the rotation. On light or acid land, where wheat does not thrive, rye may very well take its place. In high lying and northern districts, where wheat does not ripen satisfactorily, oats often follow the leguminous crop. After the beans or peas are harvested, usually there is little time for more than cultivating the stubble (with a view to killing the weeds) before ploughing. After a late or wet harvest, ploughing may be all that is possible.

Weights and Measures.

The weights and measures we use in this country are a relic of the past. Years ago, measures were largely used, no doubt, because weighing machines were not available. Naturally equal volumes of different grains have widely different weights; thus oats, being covered with husk, are much lighter than wheat. In different parts of the country different measures are used. Thus, the East Anglian farmer thinks of his corn as yielding so many coombs (4 bushels) per acre, whilst in many other parts of England quarters (8 bushels) are the standard to which farmers are accustomed. All corn is now supposed to be sold by the hundredweight, but in practice farmers still think in the old measures. It is a pity that uniformity has not been established for the whole country; but we have to recognize the facts; hence we must give the weights per bushel generally assumed for the common grains:—

	Wt. per bushel.
Wheat	63 lb.
Oats	40 „
Barley	56 „
Rye	63 „
Beans	63 „
Peas	63 „

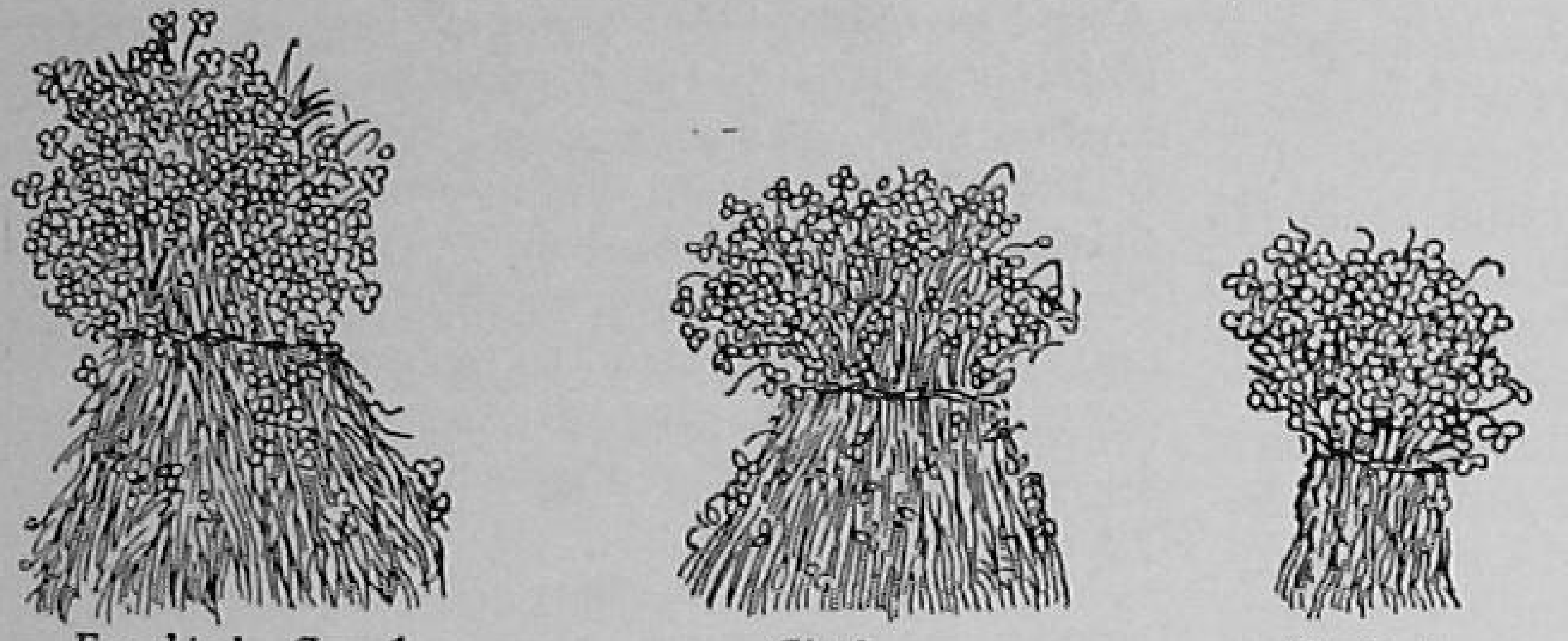
A sack (4 bushels) of wheat, rye, beans or peas, weighing 18 stones (formerly 19 stones for beans) is too heavy for any but a strong man—accustomed to such work—to carry. During the wars many less powerful people including members of the Women's Land Army, have had to handle grain. Although the adoption of smaller sacks might lead to a slowing down of threshing, yet it is difficult to justify the use of sacks so large as to be likely to injure those handling the grain.

THE SEED AND OTHER MATTERS

The importance of suitable seed is stressed. The value of seed disinfection is indicated. Our author explains why suitable and sufficient manures are necessary for the production of good crops. He shews how plants get their food from air and soil, and which are the most significant substances absorbed through the roots. The important subject of liming is discussed. It is shewn that good tillage is essential, and that this includes keeping the land free from weeds.

Suitable Seed.

In securing good crops nothing is of more importance than suitable seed. It should be pure, free from weeds, of good and vigorous germination, and suitable for the purpose in view. It should also be free from spores of disease-producing fungi as far as possible. In the case of seed grain most weed seeds can be removed by modern seed-cleaning machinery. Small seeds such as clovers and grasses are more difficult to deal with, but it is wonderful to what an extent weed seeds can be removed from them. It is worthy of note that 1 per cent. of rib-grass seed in a sample of clover may mean 15 seeds of that weed per square yard. To produce good crops, the germination capacity and vigour of the seed is of supreme importance and may make the difference between a crop and no crop or a very inferior one. The official seed testing station at Cambridge, tests seeds for farmers for a nominal fee.



Suitable Seed.—It is extremely important to use seed obtained from a suitable source. In this case clover seed from three countries was sown on the same day, in the same field, side by side. The above shows the produce of one square yard.

Seed Disinfection.*

Some fungous diseases of farm crops are carried by the spores of the disease adhering to the seed. For many years it was the practice to moisten seed wheat with a solution of sulphate of copper to combat this trouble and subsequently a solution of formalin was used; both these treatments had for their object the prevention of bunt or stinking smut. These dressings usually injured a proportion of the seed grains. Sulphate of copper could not be used for barley and oats as it destroyed the vitality of the grain. Within the past few years it has been found that certain proprietary organic mercury compounds are much more satisfactory for seed disinfection than either sulphate of copper or formalin, and their use is rapidly extending. These seed dressings are applied to the seed wheat, barley, oats, etc., in a dry state.

The following diseases are prevented by these mercury seed dressings:—

Wheat	..	Bunt or stinking smut.
Oats	..	Leaf stripe.
		Smut.
Barley	..	Stripe.
		Covered Smut.

The dressings will not control loose smut of wheat and barley because the spores of these diseases occur within the embryo.

It is desirable to disinfect the seed of rye to minimize the danger caused from root rot organisms and also to ward off other seed-borne diseases. Early sown peas should also be disinfected to lessen the danger of rotting in the soil. It is also claimed that dry rot of swedes and turnips and blackleg of beet and mangolds are checked by disinfecting the seed with these compounds of mercury. Of late it has become quite usual for seed merchants to dress the seed corn they send out to the farmer.

The operation can be performed on the farm; but the directions given by the makers of the material must be carried out exactly. Care must be taken that the workmen do not inhale the dusty material, which is poisonous. The quantity of dry dressing used is very small, usually 2 oz. per bushel of seed, and it is important that every grain should receive a coating. For that reason some simple mixing apparatus is desirable. Any drum, barrel, or box closed with a tightly-fitting lid and mounted so that it can be rotated by a handle, will serve as a home-made machine for the operation. A special machine for the purpose may be purchased. Treatment can be carried out any convenient time in advance of sowing. The cost varies from 10d. to 1/3 per acre, which is trifling compared with the benefits likely to follow from the treatment. In 1942 experiments on plots were conducted, on the Cambridge University farm, for the control of leaf stripe disease of barley. The sample of seed used appeared clean to the unaided eye, but was actually infected to the extent of 93 per cent. Of the seedlings which appeared through the soil from untreated seed, 30 per cent were diseased. The seed treated with mercury dressing gave 0·4 per cent of diseased seedlings.

* See page 170 for seed treatment for wireworm.

Manuring

"Land gets into the habit of growing good crops."
David Black.

There are few things of more importance in growing good crops than the application of suitable and sufficient manures. There can be no doubt whatever that a large proportion of our land is inadequately and often unsuitably manured. Immense increases of certain crops have been obtained by a generous use of manures. It is true that crops have a very definite limit, beyond which it is useless to manure. In the case of grain crops this limit is reached when the crop becomes laid flat in an ordinary season. In the case of root and grain crops, however, the limit is not so easily reached, and although it is quite possible to over-manure such crops as mangolds, cabbages and kale, very few cases occur where this is actually done; whereas probably 50 per cent or more are under-manured.

After a period of adequate manuring and good farming the land gets into a fertile condition in which it will generally give good crops.

Hence, in considering a scheme of manuring, it is best to think in terms of a whole rotation, remembering that the effects of, say, farmyard manure or superphosphate will probably be seen for two or three years after their application.

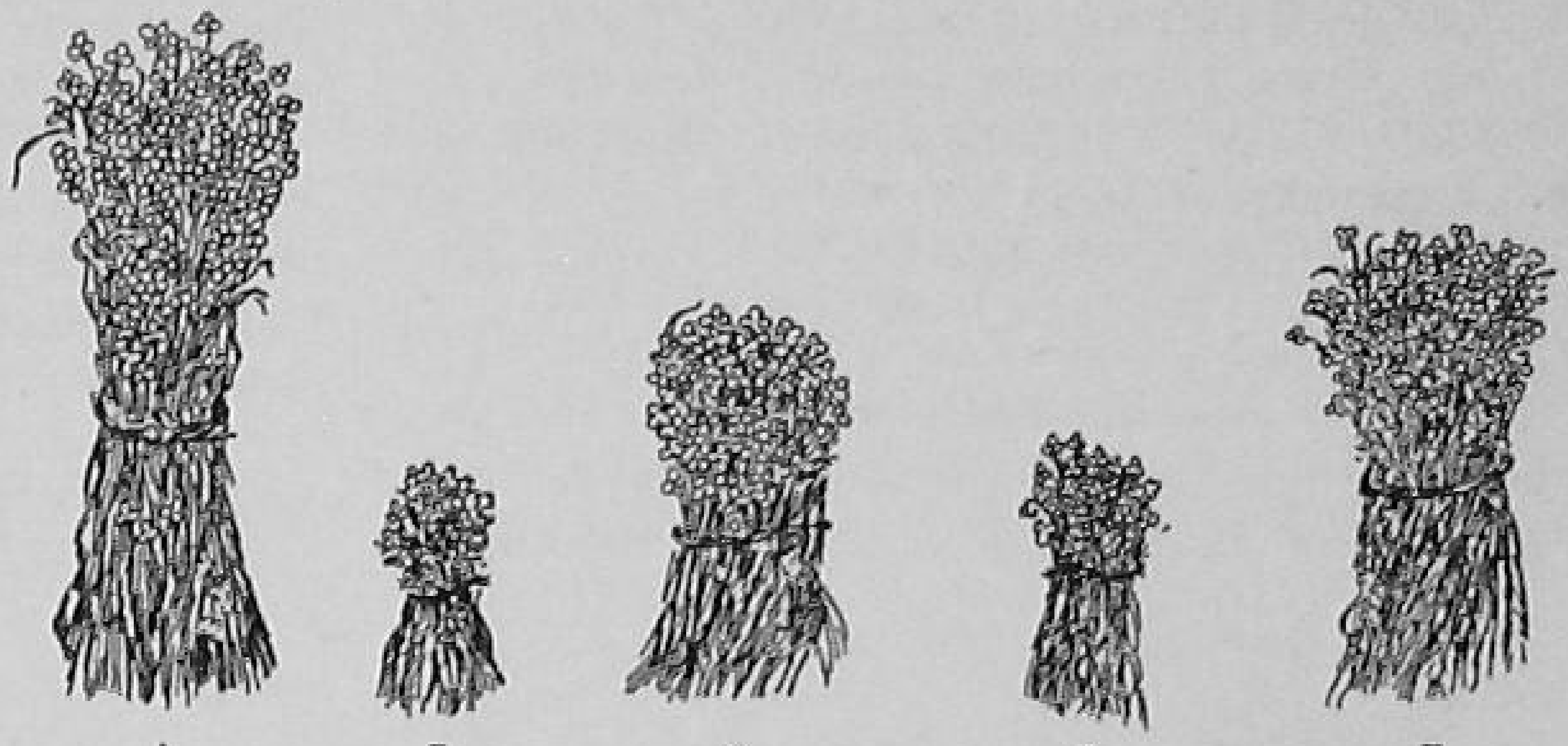
The two sources of plant food are the air and the soil. From the air the carbon which the plant requires for growth is obtained by utilizing the energy of the sun, the source of the carbon being the carbon dioxide of the atmosphere. When a plant is burned, this energy obtained from the sun is released in the form of heat and light. Water is the most important substance obtained from the soil, and very often lack of water seriously limits our crops. The soil-water holds in clear solution other substances required by the plant, and these are absorbed through the roots. From the agricultural point of view the most important substances absorbed are:—

Nitrogen.
Phosphorus—often expressed in terms of phosphoric acid or phosphates.
Potassium usually expressed in terms of potash.
Calcium often expressed as lime or as calcium carbonate.

A number of other substances are required by the plant but they are usually, but not always, contained in sufficient quantity in the soil.

Nitrogen, although present in immense quantities in the air, cannot be used from that source by most plants but must be obtained in a combined form in solution in the soil water. There is one notable exception to this—the leguminous or pod-bearing family of plants, such as peas, beans, and clovers, which by means of microbes living in their roots, are able to assimilate the free nitrogen of the air. This fact is of immense importance to agriculture, and explains why good cereal crops are usually obtained when they follow a good leguminous crop in the rotation. The cereal lives upon the nitrogen accumulated in the soil by the preceding leguminous plants. Phosphoric acid, potash and lime must be obtained by the plant in solution in the soil water. The action of the weather helps in rendering the plant-food already present in the soil more easily available. The only way in which a soil can be enriched in the mineral plant foods is by their actual addition in the form of chemical manures, lime in some form, or farmyard manure. The last, consisting of the excrement of farm animals together with litter, contains the plant foods usually taken in by the roots as well as much decaying animal and vegetable matter. Unfortunately it is usually in short supply and often of poor quality. During the past hundred and fifty years the practice has arisen of adding to the soil chemical manures containing various plant foods, and it has been found that agricultural production can be immensely increased thereby.

The principal chemical or "artificial" manures are as follows:—



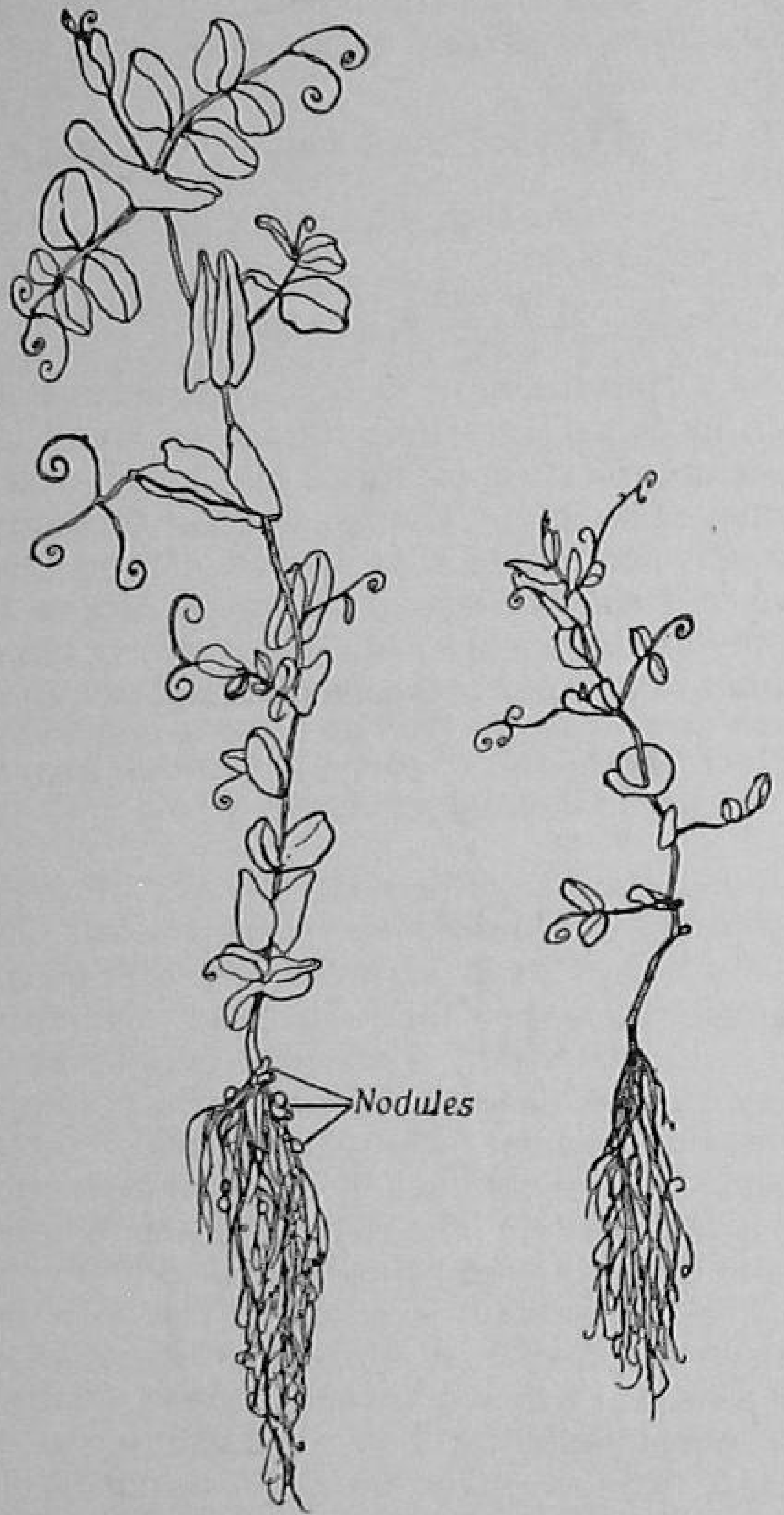
Red Clover (no ryegrass present) from Saxmundham Experimental Station. Each plot has received the same manure every year for 40 years, but has been cropped in rotation:—Wheat, mangolds, barley and beans or clover.

Plot (1) 6 tons Farmyard Manure.
„ (3) 2 cwt. Nitrate of Soda.
„ (4) 2 cwt. 30% Superphosphate.
„ (6) No Manure.
„ (7) 2 cwt. 30% Superphosphate.
1 cwt. Muriate of Potash.

Note the beneficial effects of Farmyard Manure, of phosphates, and of phosphates and potash used together. Nitrate alone is rather worse than no Manure. Clover, being able to obtain its nitrogen from the air does not require nitrogen in artificial fertilisers.

(1) Containing Nitrogen.	Nitrate of soda. Nitrate of lime.* Sulphate of ammonia. " Nitro-Chalk." Calcium cyanamide.*
2) Containing Phosphoric acid.	Superphosphate. Basic slag. Bones (also containing nitrogen). Mineral Phosphates.
(3) Containing Potash	Sulphate of Potash. Muriate of Potash (40–60% Potash). Kainit.* Potash manure salts.
(4) Lime	Various forms (see page 155).

* Not always available in Britain.



Peas.—The large plant shows nodules on the roots. These nodules enable the plant to obtain free nitrogen from the air, with the help of microbes which live in most soils and which multiply in the nodules. The small plant was grown in soil which had been sterilised. This killed the microbes and in consequence the plant was unable to form nodules and hence made poor growth.

All leguminous plants are able to obtain nitrogen from the air, by means of nodules on the roots. Their residues enrich the soil, which is thus well prepared for the next crop. This fact is an important reason for " rotations " of crops.

There is also on the market a large number of compound manures which contain nitrogen, phosphoric acid, and often potash as well.

There is no objection to the use of these provided they are good value for money and that they are well suited for the crop and soil in question.

Modern granular compound fertilizers are specially suited for use with combine drills. Some of them are highly concentrated so that only a small quantity need be used per acre, the quantity depending, of course, upon the composition of the manure.

In the past compound manures have often been rather dear, considering their composition. Those who contemplate purchasing them would be well advised to calculate their value according to the unit system.

The current unit prices are published in the agricultural press from time to time.

Farmyard manure.—The basis of the manuring of arable crops is the skilful use of farmyard manure. It is unfortunately true that, as made on nine out of ten farms in this country, a considerable proportion of the valuable constituents of farmyard manure is lost.

Very often rain falls upon it as soon as it is made and washes out much valuable nitrogen and potash whilst in the heap there is great loss of nitrogen into the air.

In order to grow the best possible crops we must consider how far this wastage can be prevented.

Farmyard manure not only supplies the chemical elements necessary for plant growth but it also provides much vegetable matter which decays in the soil to form what is known as *humus.*

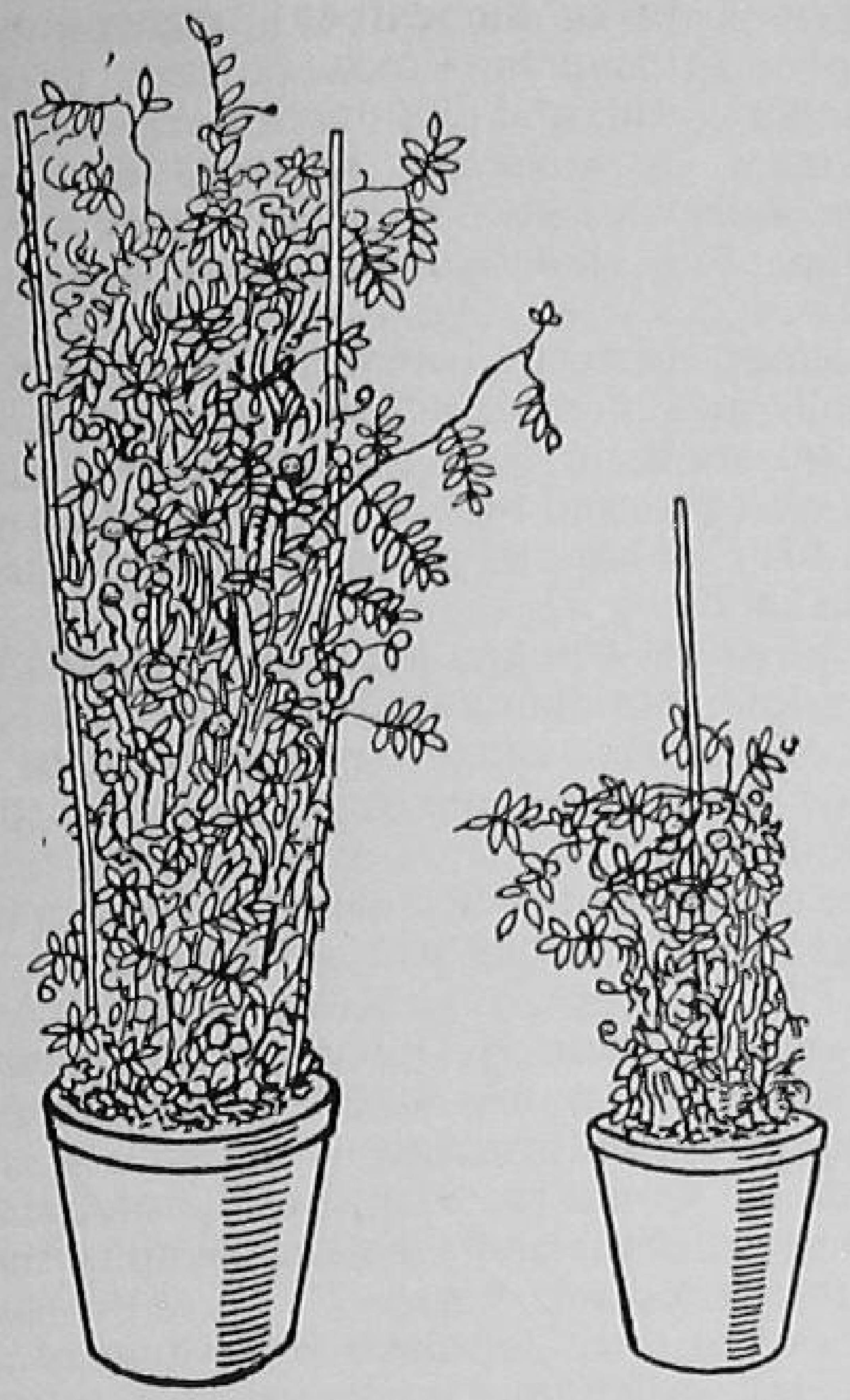
It also contains an immense number of *microbes*, which very likely have a beneficial effect upon plant growth. The humus resulting from the decay of farmyard manure is certainly very valuable. It acts as a reserve of plant foods and also renders the soil more retentive of moisture. Humus also has a beneficial effect upon the tilth of the soil. The best way of making farmyard manure is in a covered yard or shed, the manure being trampled under foot by the animals. The manure is then applied directly to the land and not stored in a heap in the open. Where the above procedure can be carried out there is no loss by drainage before application, and a relatively small amount of loss of nitrogen into the air.

LIMING.

Many soils in this country are so lacking in lime as seriously to reduce the quantity of the crops obtained upon them.

Some are so deficient that certain crops cannot be grown at all.

The seriousness of the position was recognized by the Government when it was decided, under the Land Fertility Scheme started before the War



Vetches, grown on acid soil. Part of the field received a dressing of chalk five years previously, the other part was untreated.

of 1939, to give a subsidy upon the use of lime. Later this subsidy was one half of the cost, including spreading.

The cause of soils being poor in lime is largely geological. Some rocks contain little or no lime, and when they weather down, the soil must of necessity also contain very little. Then again lime slowly dissolves in rain-water, and in the course of geological ages, gradually disappears, especially from sandy soils which are easily penetrated by water.

Hence we find that light soils as a general rule are poorer in lime than heavy soils.

In certain districts the acid fumes from industrial works have helped to impoverish the soil in lime. To those whose knowledge of chemistry is slight the terms connected with lime are rather confusing; a brief explanation is therefore given.

Lime, sometimes called quicklime or lime shells, is known to the chemist as *calcium oxide*. The chemical formula is CaO. The farmer may buy " lime " in a number of forms

(*a*) In the uncombined form as—

Burnt lime . . . .
Lime shells . .
Quick lime . .
Lump quicklime . .
Ground quicklime

} All these are *calcium oxide* (CaO) with natural impurities present

or (*b*) combined with water as Hydrated lime—Chemical formula, $Ca(OH)_2$

or (*c*) combined with carbon dioxide as carbonate of lime—chemical formula, $CaCO_3$. Other designations of this are:—

Calcium carbonate.
*Ground carbonate of lime.
*Ground limestone.
*Ground chalk.
*Lump chalk.
*Waste limes such as *Sugar-beet lime sludge or *Crusher limestone dust.

* All these contain varying proportions of natural impurities.

On average analyses, the following amounts of each material given below are likely to contain equal weights of calcium oxide. Provided good distribution is effected they are all likely to give good results.

2¼ tons of Ground burnt lime, or Quicklime in any form.

3¾ tons Ground carbonate of lime, Ground chalk or Ground limestone.

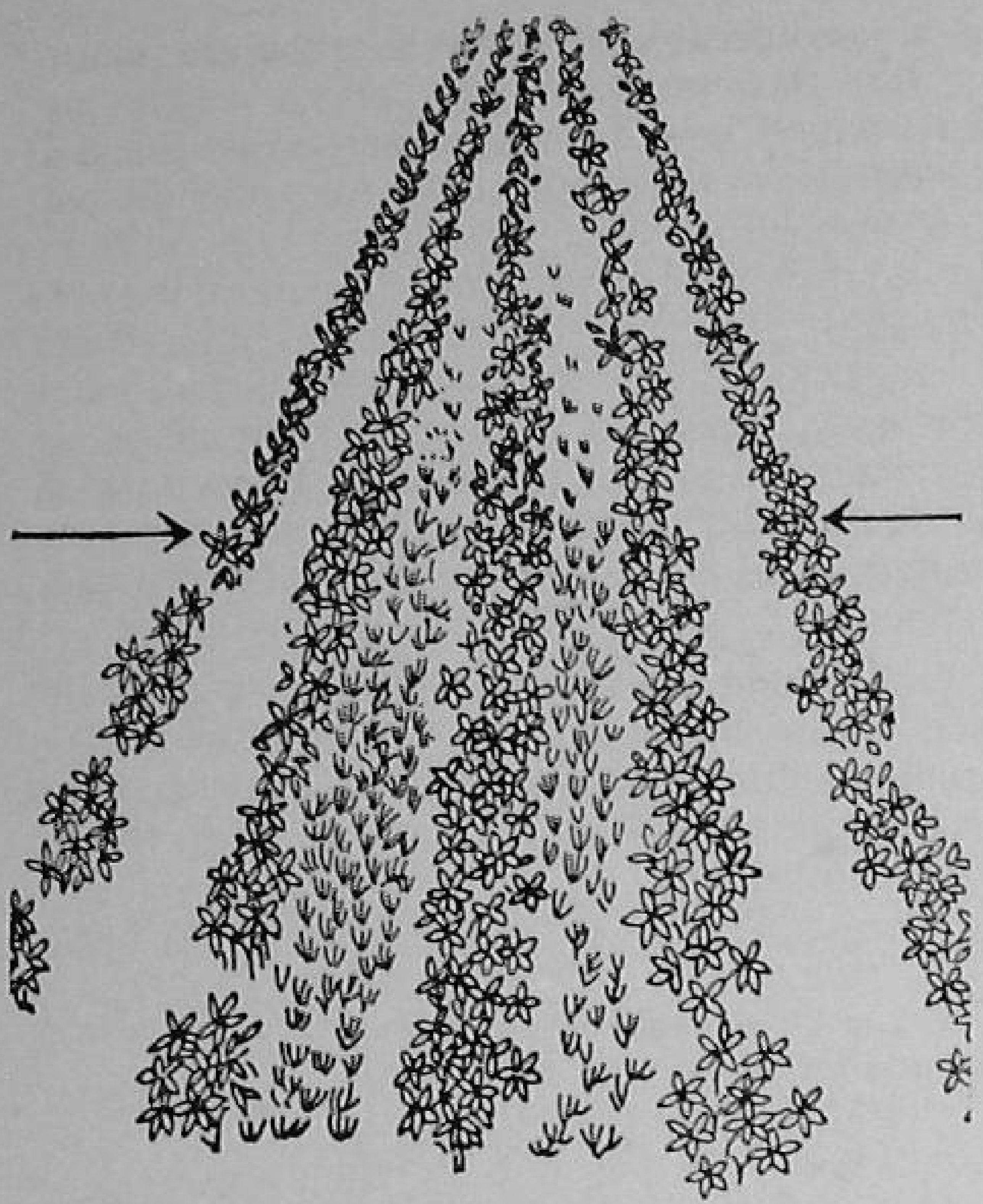
5 tons Soft lump chalk.

8–10 tons Sugar-beet lime sludge.

As a rule the more bulky untreated materials such as Sugar beet lime Sludge or Small lump chalk are the cheapest forms of " lime " near the source of supply. The usual small dressings of ground material such as 10 cwt. Ground burnt lime or 1 ton of Ground carbonate of lime only supply about a quarter of the quantity of calcium oxide to be found in 5 tons of chalk.

Barley.

The above, taken from Tunstall Experimental Station, shows the effect of lime (in this case in the form of chalk) upon barley grown in an acid soil. The chalk was applied several years previously. There was practically no crop on the un-chalked land.



Effect of Lime upon Weeds, on an acid soil. The land in the background received 5 tons of chalk per acre several years previously and grows very much less spurrey, than the foreground, which was unchalked. The two centre rows were not hoed. The grass-like weed so conspicuous in the foreground is spurrey. The crop is lupins.

Signs of Lime Deficiency

Signs of poverty of the soil in lime.

(1) The presence of the weeds, spurrey (Pick-purse Dother or Make-beg), sorrel and annual knawel in quantity, is an almost certain indication. Corn marigold, *Viola tricolor*, and wild radish, are often found under acid conditions.

(2) Poor crops of clover, lucerne, peas, tares, barley, sugar beet and other lime-loving plants. The complete failure of these crops in large patches in a field often indicates that these patches are specially poor in lime.

(3) On grass land the presence of dense spongy mats of undecayed vegetable matter on the surface. The absence of clover or presence of inferior grass which stock will not eat, may also indicate lack of lime.

Indications of plenty of lime.

(1) An abundance of chalk stones and particles of limestone, especially when these are soft and break down easily.

(2) Lime-loving plants succeed well. Chemical analysis of the soil is very useful and accurate in ascertaining whether lime is needed. There is also a very simple test with a coloured liquid (put on the market by British Drug Houses) by means of which a soil can easily be tested by those with little or no knowledge of chemistry. For this reason it is extremely unwise for anyone to start liming his soil until he has first ascertained by means of a test, whether it really needs lime.

There can be no doubt that, in the past, large quantities of lime have been applied to soils which did not need it and which did not benefit from it in any way. At the same time those whose soils needed lime very badly have sometimes found it difficult or impossible to get it.

The method of application of materials containing lime is important. The object is to get an intimate mixture of the materials with the soil. It is useless to go to the expense of grinding or burning lime and then, by neglect, allow it to go back to its original state, or a state equally difficult to distribute.

Quicklime may be applied in the ground form with the aid of a manure distributor or even by means of a shovel. It is very apt to get in the eyes of workmen, and protection should be given by means of goggles. Immediately after application the land should be harrowed, in order to mix the lime with the surface soil and prevent it from going into a cake. When this happens it is impossible to obtain really good distribution.

Quicklime in lumps may be left in the field in small heaps until it is slaked by rain. It should be carefully watched and spreading should be carried out immediately it reaches the dusty stage and before it becomes " pasty." Once the pasty stage is reached uniform distribution is impossible.

Ground carbonate of lime will usually be applied by means of a manure distributor. The land should be harrowed immediately after application, if possible, in order to mix it with the surface soil and so prevent it going into a paste.

Waste lime, such as Sugar beet lime, Sludge or sludge-like material from water-works, may be spread on the land. If it is harrowed when dry, very good distribution may be effected.

Lump chalk should be spread upon the surface after the last ploughing, in autumn or early winter, and left there all the winter. It will then be broken down by frost to a surprising extent. Soft chalk, such as occurs in some districts, will, in a winter of a fair amount of frost, become shattered almost to powder, especially if it is harrowed from time to time.

The importance of liming where it is needed can hardly be exaggerated.

If we are to farm such land we cannot afford to neglect liming.

The figures obtained at Tunstall Experimental Station, in Suffolk, on a light soil poor in lime, afford almost incredible evidence of this.

In 1926, a field of light land, poor in lime, was taken over by East Suffolk County Council. Half of it received a dressing of soft lump chalk, which was the cheapest local source of lime. The other half of the field received no chalk.

The cost of the chalk, including spreading, was 50/- per acre.

The field was divided into eight half-acre plots, so that in the same year four duplicate plots of each crop of the four-course rotation could be

grown. Each crop being half on chalked land and half on unchalked.

Every year since 1926, manuring has been uniform for both chalked and unchalked land.

It has been found that certain sensitive crops, such as sugar beet, barley, carrots, parsnips, and clover grow no crop at all on the unchalked land, whilst where the land was chalked in 1926, good crops have been obtained for 22 years without further chalk.

Thus in 1948 an average yield of 16·7 tons of washed sugar beet was obtained on the chalked land, and no crop at all on the unchalked.

In the five years ending in 1941, the average crop of peas on the chalked land was 34·4 bushels, and on the unchalked land only 4·7 bushels.

With wheat—not a very sensitive crop—the average yield of grain in three years was 36·6 bushels on the chalked and only 16·6 bushels on the unchalked land.

In another part of the same field different quantities of lime (as ground chalk) were applied in 1932 at the suggestion of Sir John Russell. In the first 9 years of the experiment, the extra crops on the plot which received 2 tons per acre of ground chalk (carbonate of lime) were worth not less than £240 per acre more than those on the untreated plots, which were mostly complete failures. In this series of experiments very sensitive crops such as sugar beet, barley, clover, and carrots were grown.

Rapidity of Action.

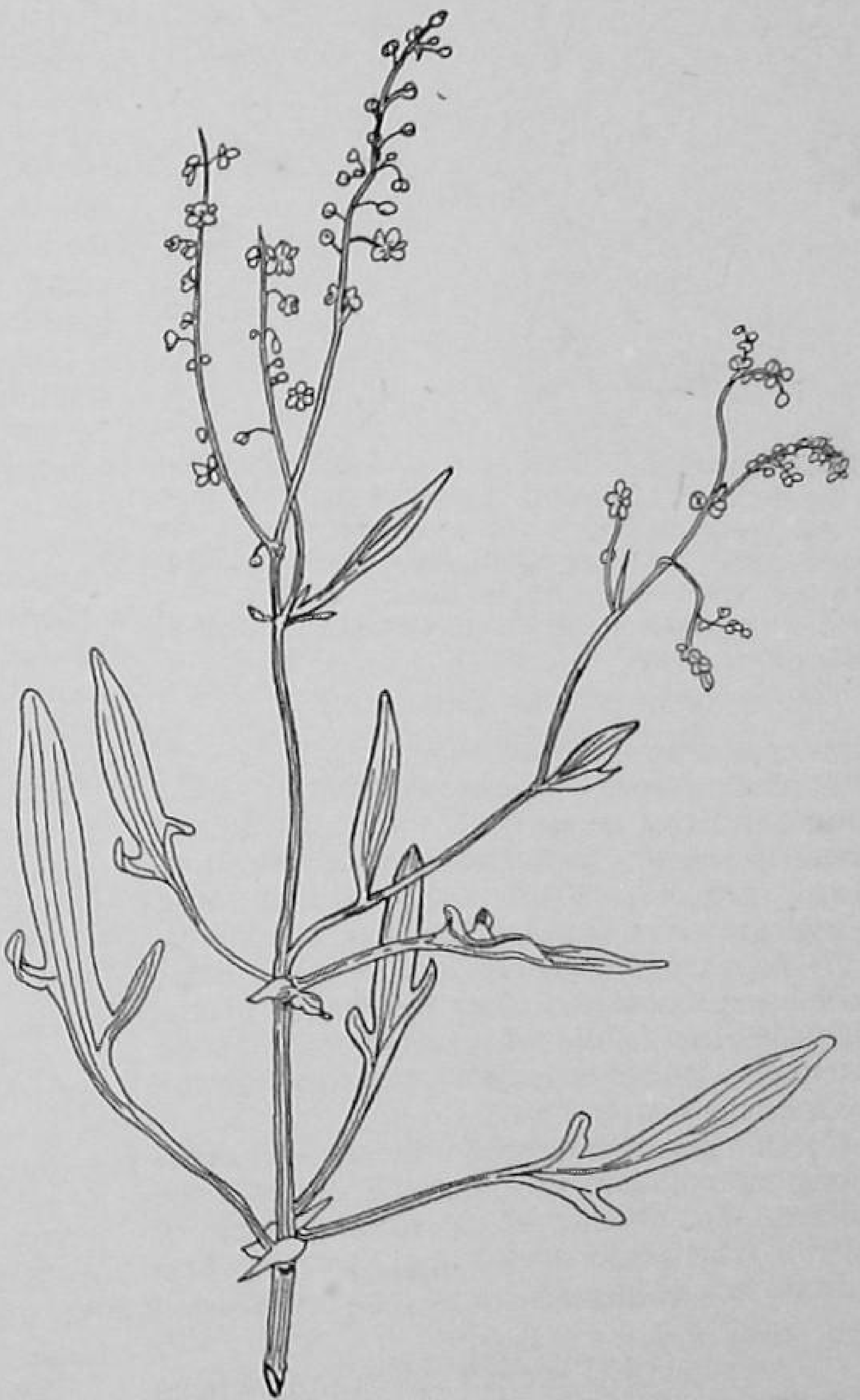
All forms of lime take time to act, and it is a mistake to put a highly sensitive crop on very acid soil, even after it has been limed, until a year or more has elapsed. The wisest plan is to apply the lime, and then put in such crops as oats or potatoes, which will probably not be a total failure, even if the lime does not have much effect at once.

There is evidence that the quickest results are obtained where lime is left on the surface and worked into the soil in such a way as to be in contact with the germinating seedlings of the crop. Thus a dressing of lump chalk applied to the surface of the soil in January, at Tunstall, and not ploughed in, resulted in a satisfactory "take" of clover sown in the following April.

Duration of Dressings.

Small quantites of ground lime or limestone, or chalk—10 cwt. to 1 ton per acre—may not last very long, especially if the soil is rather acid, and may require to be repeated at intervals of a few years. On the other hand heavier dressings of chalk or of the various forms of waste lime may last a considerable time. Where the lumps are not very fine, particles break off by weathering every time a new surface is exposed by tillages. The effects on the crops of five tons of chalk per acre, applied in 1926, at Tunstall in Suffolk showed no very obvious signs of falling off in 1949.

Several cases have occurred in which the effects of very heavy dressings of chalk applied 40 years previously, were still evident. The question as to which form of lime to use depends upon which can be obtained locally at the cheapest rate, taking a long view as to the results likely to be obtained.



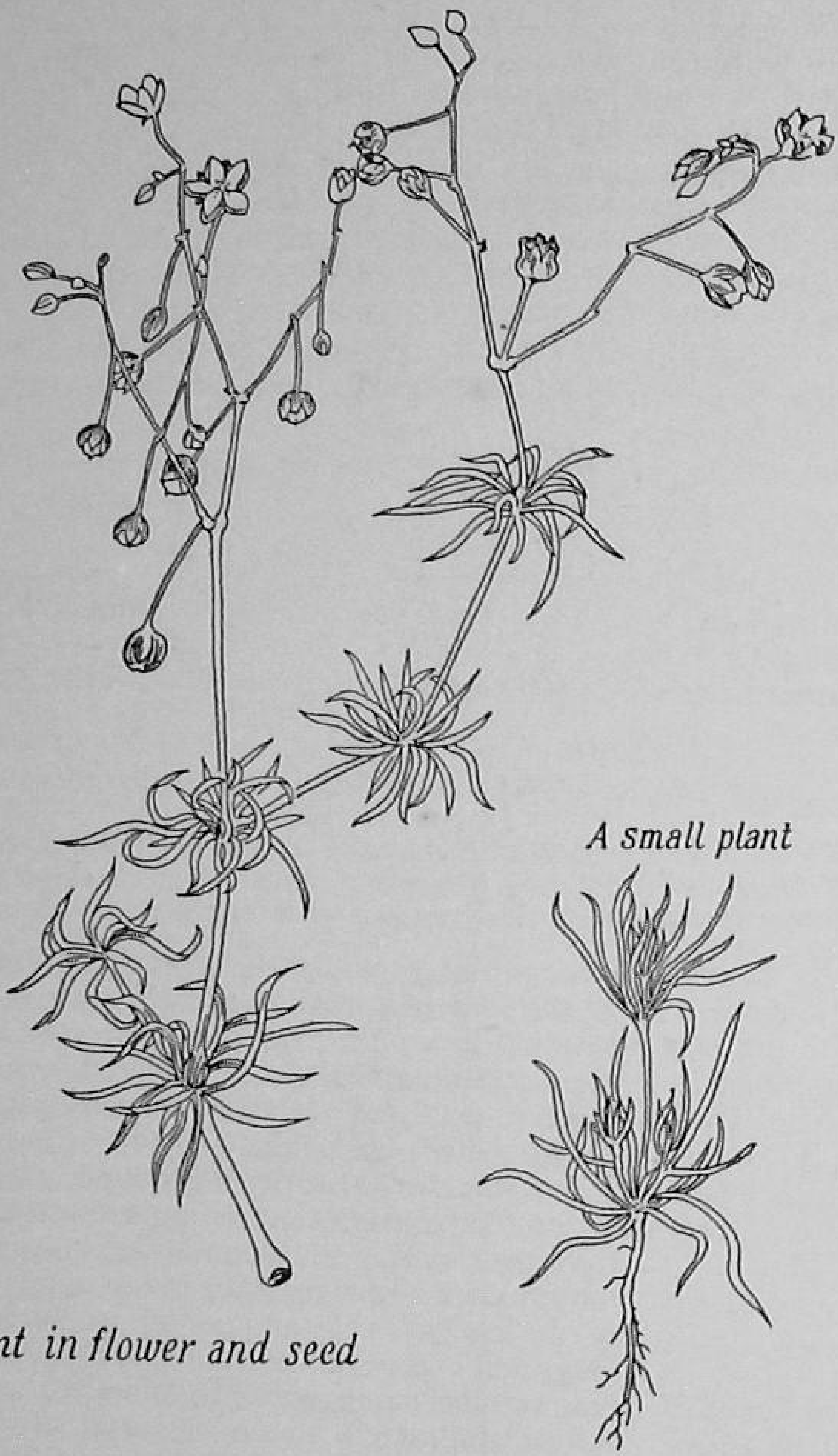
Sorrel.

A weed indicating soil acidity or lack of lime.

Soils containing sufficient lime.

Many soils in this country contain sufficient lime for the requirements of all crops. Where this is the case it is unlikely that the application of further lime will give any benefit—in fact it may do harm by increasing the liability of crops to boron-deficiency diseases. Since the introduction of the Government subsidy on lime it is probable that immense quantities of

lime have been wasted by application to soils which do not need it. This could have been prevented by giving the subsidy only to those whose soils had been tested by an experienced person, and certified as likely to benefit by a dressing.



Spurrey.
A weed indicating soil acidity or lack of lime

Tillage and Weeds.

"We cannot afford to grow weeds."—*John R. Keeble.*

It is impossible to grow good crops without good tillage, which includes keeping the land free from weeds as far as this is possible.

The modern farmer is in a much better position to overcome difficulties due to weather condition than his grandfather, who depended almost entirely upon horse and hand labour.

It is impossible to plough more than a certain area—¾ to 1½ acres of land in a day, with a man and a pair of horses. Both man and horses get tired; but given a change of driver, a tractor can work all the hours of daylight and never get tired. Hence the farmer now finds it possible to do work which formerly could not be done, provided he has men and mechanical implements.

Immediately a field is cleared of shocks in harvest, the stubbles can be cultivated to a shallow depth to germinate weed seeds; or they can be ploughed a few inches deep or rimpled or riffled, i.e. ploughed without turning over to expose the land to sun and wind, and so that weeds are killed. Many farmers arrange to have a man and a tractor engaged in doing work on the stubbles while the other men are finishing harvest. In a dry September, after an early harvest, this work has an extraordinary effect in getting a farm clean.

Powerful tractors also enable the land to be ploughed much deeper than it has ever been ploughed before. This increases the depth to which roots can penetrate, and provided subsoil is not ploughed up, increases the amount of soil from which the plant can absorb its food. In the past much has been written about the undesirability of bringing up subsoil and "dead" soil and no doubt this is a right view; but it is probable that by gradually increasing the depth to which the plough goes, the productivity of the land is increased.

Deep ploughing is especially beneficial for root crops where a pan, or hard layer exists 10 inches to 1 foot below the surface. Much good is done by penetrating this, in the operation of sub-soiling. A pan such as that referred to, prevents water and plant roots from penetrating the deeper layers of the soil and greatly reduces the crop. Sub-soiling can easily be performed by modern power-drawn implements, and under some conditions may be most useful; under others it may be useless.

Then again, the rapidity with which the work of ploughing can now be performed in the autumn and early winter, enables the heavy-land farmer to be more master of his work and to get his land ploughed up ready to take advantage of the frost in making a good tilth.

There is no tilth so good for germinating seeds as that made by nature—the winter mould. It is caused by the action of frost, due to the fact that when water freezes, it expands. This shatters and breaks up impervious clays and brings them into a friable condition suitable for germinating seeds. The art of good tillage can

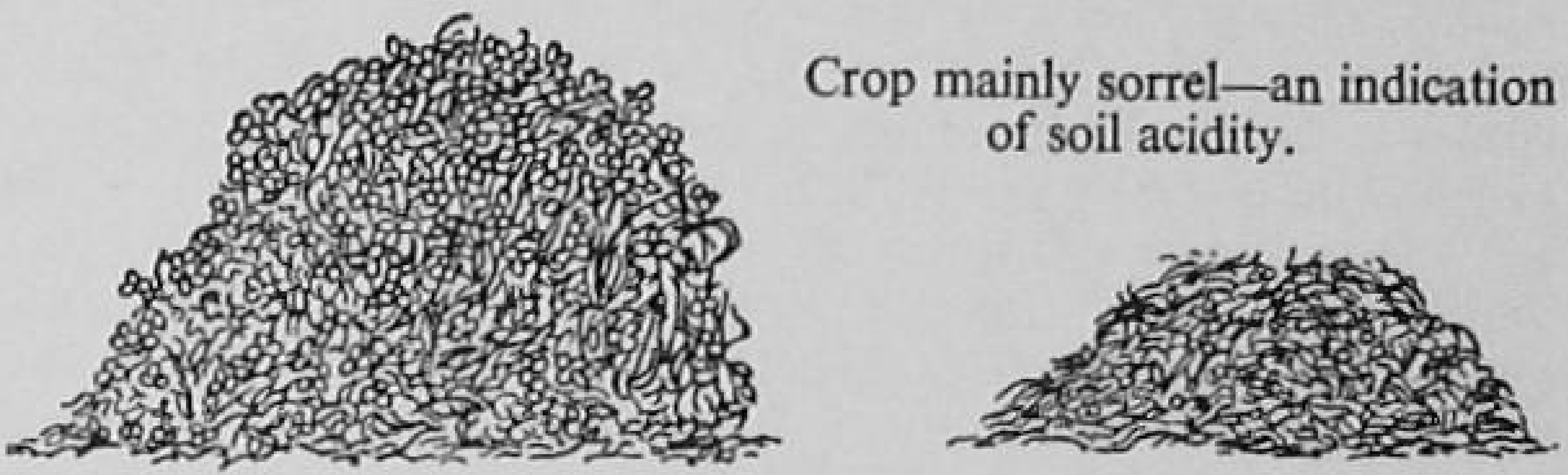
only be learnt by practical experience in the field; but there are many with experience, who do not put it into practice.

"We cannot afford to grow weeds," said Mr. J. R. Keeble, one of the most famous of Suffolk farmers, to the writer, on one occasion, and if *he* cannot afford to grow them, we may be certain that the ordinary working farmer cannot afford to do so either. The land can only grow one crop at a time and if it grows weeds, it will not grow corn or roots.

Moreover, once land is thoroughly clean, it may be kept clean with comparatively little labour. All farmers, therefore, are well advised to take every possible opportunity of getting rid of weeds. Sometimes this can be done by means other than tillage. Heavy crops have a great effect in crowding out weeds. There are not often many weeds in a really heavy crop of kale, of potatoes, or even of wheat. Hence generous manuring may help. We have found at Tunstall that on the unchalked part of a naturally acid field, we have the greatest difficulty in keeping down the weeds sorrel and spurrey which grow on acid soils. On the other part of the same field which had five tons of chalk per acre 22 years ago, there is no difficulty. This effect will, of course, only be seen on land that is poor in lime. It is most strikingly evident every spring, at Tunstall. In the short space at our disposal it is impossible to deal with the very numerous tillage problems which constantly arise in every month of the year. Those who desire to get a thorough mastery of these will do well to discuss them with the practical men with whom they are working, on every opportunity. Very often the farm worker is extremely skilled in tillage and knows as well as anyone how to treat the land under some particular condition. This can only be learnt by experience.

Such problems as whether the land requires another ploughing—whether it should be rolled or not—ought it to be harrowed?—which are constantly arising can only be decided on the spot by the man of experience, and even he may not always be right. Sometimes a given course may be successful if certain weather follows, but unsuccessful under other weather conditions. Keeping weeds in check, is a great art, and it requires constant watchfulness to deal with them at the right stage. "The time to horse-hoe is when you cannot see any weeds," was once said by a very good arable farmer (the late Mr. Walter Smeeton). What he meant was that there are usually millions of weed seeds just germinated and hardly visible. These are killed very easily and quickly before they do any harm. The same weeds left for a fortnight will possibly have ruined the crop and will be very difficult to kill. They will also block up the horse-hoe and cause endless trouble.

Hence not only must the right work be done, but it must be done at the right time if at all possible.



Showing the necessity of enough lime in the soil in order that Clover may grow normally.

White Clover grown on acid land. The chalk was applied on the surface of the ground in January. It was not ploughed in, the clover was sown in March and a good plant resulted where the chalk had been applied.

Weed Destruction by Spraying and Dusting.

Of late very great progress has been made in the destruction of weeds in young crops by spraying and dusting. Certain of the materials used contain plant Hormones which are absorbed by the leaf and cause contorted growth and subsequent death of the plant. A number of weeds including charlock, and wild radish (runch or warlock) may be killed by dusting with a proprietary material, sown with a manure distributor. Not only cereals, but a number of other crops may be successfully sprayed for weed destruction, provided the right conditions prevail at the time of spraying, and the right material is selected to kill the most prevalent weed and leave the crop unharmed. Space does not permit a consideration of the materials recently introduced. Using the wrong material, or the wrong strength of material for the crop in question, may lead to serious damage or even to complete destruction of the crop. Some of the materials are poisonous and require care and experience in handling. In view of the considerable amount of technical knowledge and experience necessary in order to get the best results, many prefer to enlist the service of skilled contractors to do the work of spraying. Dusting cereals however is comparatively easy and can be done very efficiently by the farmer. There is no doubt that the destruction of weeds by chemical means is one of the most important contributions made by science to food production during the past few years and rapid progress is still being made.

However, unless there are many weeds, it may be better to combat them by horse-hoeing,* harrowing, and hand weeding. Oats must be harrowed with care, as spring oats are more easily damaged than is barley.

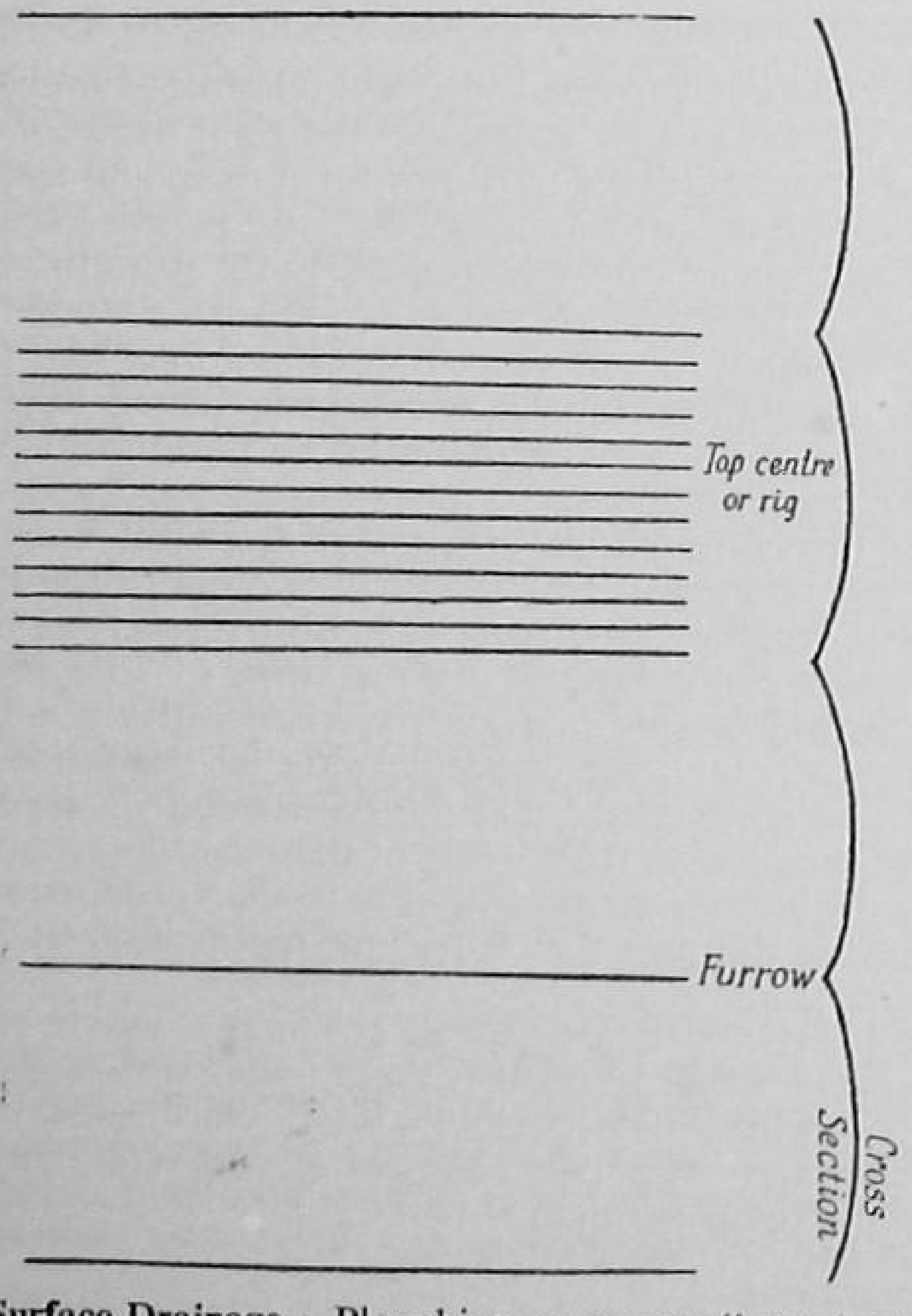
* Throughout this section the expression "horse-hoeing" includes any mechanical means of hoeing crops in rows.

MAINLY ABOUT LAND

The first topic here is Drainage, and it is briefly explained. Then comes Irrigation, of which our author gives an interesting account. Brief allusion is made to the subject of Land Reclamation. An important discussion entitled "Good Crops from Bad Land," follows, and a great many particulars of practical value are included. The section is brought to a close with an account of Stacking and Thatching.

DRAINAGE.

THE subject of drainage includes both arterial and field drainage. The first of these is connected with the streams and rivers, and is largely controlled by public bodies. Field drainage, however, is the concern of the farmer. The lighter types of soil, especially in districts of low rainfall, do not require artificial drainage since any surplus water sinks in to the porous subsoil. Really heavy land, however, requires drainage even in the driest parts of England. There are times in all parts of the British Isles, where after heavy rains all but the lightest soils become water-logged and no British agricultural plant will make satisfactory growth under such conditions. The excess of moisture drives the air out of the soil, with the result that roots cannot penetrate and the young plants develop an inadequate root system. This renders impossible the absorption of a sufficient amount of plant food. When a dry time comes the plants may suffer from drought owing to the small root system. Drainage, which also helps the air to penetrate the soil, encourages the development of an adequate root system and hence may actually help the plant to withstand drought on heavy soils.



Surface Drainage.—Ploughing on narrow "stetches" or "lands" often only 8 feet wide. The horses walk down the furrows when harrowing and drilling.

Surface Drainage.

Our ancestors thoroughly understood the value of surface drainage. This is shown by the high ridges or rigs and deep furrows so common in the heavy land districts of the Midlands. Much of the land immediately before the Great War 1914–18, was in grass, but the ridges and furrows were relics of the time when it was arable land. The narrow *stetches* or *lands*—often only 8 feet wide—of the eastern counties, are also designed for surface drainage.

The surface channels, or water furrows, to conduct the water away from the lowest point in each furrow, become obliterated during tillage operations, but immediately drilling and harrowing are complete, the careful husbandman cleans them out again with plough, spade or shovel, to enable surplus water to escape rapidly. The introduction of modern machinery, which does not fit in very well with surface drainage, tends to discourage this old-fashioned but excellent system of dealing with surface water. Some soils, however, are so impervious that the water does not readily penetrate to underground drains and to get the best results surface drainage is absolutely necessary. Of late, in Essex, it has been found possible to use four furrow tractor ploughs to make narrow *stetches* or *lands*.

Underground Drainage.

It is probable that underground drainage, by means of stones or bushes, or both, inserted in trenches cut to a depth of 2 to 3 feet and sometimes more, has been practised for a very long time. Rough and angular stones are reasonably efficient and where they are found in quantity—often in the field to be drained—they are still used. "Bushes," i.e., material 3 or 4 feet or more in length, cut from the hedges and inserted in trenches also last some years, even when there are no pipes or tiles underneath. In fact, it is probable that they continue to take a certain amount of water away for a very long time. Bushes are extensively and rightly used for putting on the top of drain pipes to keep the soil open and prevent it from becoming puddled down so that the water does not gain access to the pipes. Indeed, it is probably wise always to cover the pipes with bushes. On boggy soil, where pipes are apt to become displaced, bushes may be a most satisfactory form of drainage. Under boggy

conditions wooden tubes, several feet long, and of a square section 9 in. by 9 in., or so, have also been found useful.

Pipe and mole drainages have been introduced more recently than stone or bush drains. In the past, pipes were of various shapes but now cylindrical pipes, 1 foot long and of varying diameters, are most common.

In pipe draining, the field is carefully surveyed. One or more main drains are made, often not far from the ditch, and in any case down the lowest parts of the field and into them side drains run. It is beyond the scope of this work to consider the many details of pipe draining. The labour and cost involved in doing the work by hand is, however, great, and much attention is at present being devoted to devising efficient methods of making the necessary excavations by machinery.

These investigations have met with a considerable measure of success. A machine has even been devised which will bury the pipes without actually opening a trench. In mole draining, an iron plug is drawn through the clay. This leaves a channel which is conducted into a main drain (usually of pipes) and down it the water runs.

Formerly, mole draining was carried out by horsepower, with the aid of a "round-about." Now, however, it is invariably the work of steam or tractor power.

On certain types of subsoil, mole draining is remarkably efficient, and, as it is very much cheaper than pipe draining, it has much to recommend it.

Both mole and pipe draining have received subsidies during the second great war because it was recognized that they have a very great effect on food production.

Irrigation.

"And a river went out . . . to water the garden."—
Gen. ii. 10.

Irrigation.

We in Britain think of "gentle rain from heaven" as the source of water. However, in many countries it has been irrigation, and not direct rainfall, upon which for thousands of years the most fertile land has depended for its water. The valleys of the Nile, Euphrates and Tigris—cradles of our most ancient civilizations, relied for their fertility upon water brought down by the rivers from mountains hundreds or even thousands of miles away.

In Britain irrigation has been practised to some extent in certain districts. Between 1816–1837, the then Duke of Portland spent over £30,000 on the construction of water meadows in the area of light land in north Nottinghamshire.

The great Bakewell, pioneer of the breeding of live stock, irrigated his meadows at Dishley, near Loughborough. Water channels used by him could still be seen when the writer inspected his farm a few years ago. Water meadows are still in existence in various parts of England.

The system of overhead watering introduced in recent years, has made considerable progress in market garden areas. It is the considered opinion of the writer that if the agriculture of Britain is to be developed as it ought to be, irrigation should be widely used in the drier districts, especially on light land, and where valuable crops are grown. The extreme dryness of certain districts in Eastern England is hardly realized by those who reside further west. Thus in Suffolk in 1943 the rainfall for the six months commencing 1st February was 6·29 in. Such a small rainfall in spring and early summer results in very poor growth of grass, even on heavy land, and on light land there is hardly any growth at all. Corn crops were not as a rule seriously affected in 1943 except where, owing to the dry seed bed, spring corn failed to germinate, but on light land, roots, green crops and potatoes were very seriously below their normal yield. Market garden crops especially suffered most terribly.

In East Anglia which is apt to suffer severely from drought, Root crops and Grass often greatly benefit by irrigation.

As a result of nearly 40 years' experience in East Anglia, the writer thinks that, in two seasons out of three, crops on light land are seriously reduced by drought. In countries where irrigation is adopted, lucerne has been very successfully used as a means of enriching the soil. In East Anglia it will grow extremely well on light sands containing enough lime, but its growth is frequently greatly reduced by drought. If it were irrigated, three good cuts could be obtained annually—an immense quantity of valuable cattle food would be produced and the land would be greatly enriched.

Irrigation would thus render possible the cultivation for food production of large areas of light sandy land which have hitherto produced very little. The fact that crops so often fail owing to drought has rendered the cultivation of this land relatively unprofitable, and large areas went out of cultivation between the two great wars.

Land Reclamation.

Land Reclamation.

It is beyond the scope of this little work to do more than briefly allude to the immense subject of land reclamation. During the second great war much experience of this has been gained and the methods adopted differ widely under various conditions.

Hill-land.—On the Welsh hills, sometimes much above the thousand feet contour line, the methods

developed by the Aberystwyth scientists at Cahn Hill Research Station and elsewhere have been largely adopted. Bracken four feet high has been buried by immense ploughs about midsummer. The land has then been limed and slagged and sown with a mixture of turnips and rape. In the cases inspected by the writer this crop, favoured by the high rainfall, has proved very successful. It was fed to sheep and the land planted with potatoes next spring, after repeated cultivations with the disc harrow. This implement does not bring the bracken roots to the surface. Oats, undersown with grass sometimes followed the potatoes. In other cases the land was directly re-seeded with grass and rape in mixture. Almost incredible improvements in productivity have resulted from various methods such as those above mentioned. It appears safer to sow a "pioneer" crop such as rape and turnips, which costs little for seed and cultivation, as the first crop after breaking up hill-land, than to put in more expensive crops. In the Derbyshire hills and in other hilly parts of England local agricultural scientists have been instrumental in introducing similar methods, with remarkably good results. When inspecting some of the work in Derbyshire a while ago the writer concluded that if all the cultivable hill land in England were treated by such methods its productivity would be multiplied many times.

Land of Average Elevation.

Much land of this type has been reclaimed, including heath and commons in various districts. Very often the methods adopted have been similar to those on the hills—the surface vegetation being buried deeply and lime and phosphates applied where necessary. Where cereals have been grown as a first crop, success has not been by any means universal, in fact many failures have occurred, and it seems probable that where conditions are very unpromising the "pioneer" crop which involves relatively little expense or labour and seed is to be preferred. This gives time for the original vegetation to decay. In eastern England dry weather in spring has probably been the cause of the failure of the first crop in some cases. Much heavy land covered by thorn bushes has been reclaimed. In some cases these have been pulled up by chains attached to tractors or steam engines. Smaller bushes have been gyrotilled up. On heavy land of this kind, beans have proved a suitable first crop to grow whilst wheat has not infrequently been grown successfully. Very often drainage has been necessary, and as a rule dressings of phosphate have been very important. In dealing with land of moderate elevation a greater choice of crop is possible than with hill land.

Low Lying Land.

Low lying land near rivers and in fen districts—much of this land has been brought into cultivation. As a rule the chief difficulty has been to get rid of the water. Usually there is a great depth of soil and the surface vegetation has easily been buried by immense ploughs. Where the land is acid some form of lime has been applied.

In one area of this kind known to the writer, almost at sea level it has proved impossible to grow winter crops owing to the high water table, but very good crops of spring corn, roots and potatoes have been grown. Very often such soil contains an immense store of fertility—the difficulty is to render the conditions suitable for the growth of crops.

GOOD CROPS FROM BAD LAND.

"I'a stubb'd Thurnaby Waäste."
TENNYSON—*Northern Farmer.*

The amount of really good land in this country is relatively small. There is a large quantity of average land which will grow good crops if well farmed, and there is an immense area of so-called "marginal" land. In the years between the first and second world wars this "marginal" land was often considered not worth cultivation by hard-headed business men who, it is to be feared, sometimes did not care what became of the land so long as a financial profit was secured. Since the outbreak of the second great war much of this "marginal land" has been cultivated by War Agricultural Executive Committees and private individuals, and a large proportion of it has proved capable of producing an immense amount of food, not infrequently with comparatively little expenditure of labour. There can be no doubt that modern science and modern implements together have entirely altered the position and have rendered large areas of "marginal" land no longer marginal, but have placed it in the category of land which can and ought to be permanently cultivated in the national interest. It is to be hoped that we shall never again have the deplorable spectacle of a government department (The Forestry Commission) acquiring easily cultivable agricultural land, planting it with trees and thereby rendering its cultivation impossible for a long period of years, and then only by the great labour of removing the tree stumps. This occurred in Suffolk where, in March, 1940, after the outbreak of war, a 20-acre field of rye stubbles was planted with trees by the Forestry Commission. On the field immediately adjoining, 20 tons of sugar beet per acre had been grown two years previously.

"Why is the Land Bad?"

Anyone taking over the care of "bad land," would be wise to consider carefully why the land is "bad." If the cause is bad farming, obviously the thing to do is to cultivate well, manure well, and farm well in every way. Sometimes,

however, there is some other cause at work which must be found out. A very wise plan is to dig down deeply into the soil. A large common in Suffolk had, as far as is known, never been cultivated. It was covered with poor grass, the soil was very light and yet in winter water stood over most of the common. On digging down it was found that the sandy surface soil was only about 2 feet deep and that below this was an impervious layer of clay which held up the water. The first procedure, therefore, was adequately to drain. On testing the soil on the surface it was found to be extremely acid, so acid that practically no clover grew in the original grass. Thus modern science very easily ascertained the second great cause of infertility—lack of lime. The original suggestion made for this land was to drill it with wheat; a crop which probably had no chance whatever of succeeding. Oats, a crop capable of withstanding much acidity, was finally drilled with a very fair measure of success.

Another case occurred on a light land field covered with small brambles, etc. This was gyrotilled and most excellent work done. The brambles were burned and the land cleaned—all very sound work. Those in charge did not, however, consult anyone with a knowledge of agricultural science but put the field in with barley. The result was a hopeless failure owing to soil acidity—lack of lime—a matter which could have been sufficiently tested in five minutes. The field was within about 4 miles of an abundant supply of soft chalk and could have received enough chalk to render it fertile for 20 years at a very small cost.

These two instances show that those taking over derelict or semi-derelict land would be well advised to consult with the National Agricultural Advisory Service, as these scientists may very likely be able to make suggestions which may save hundreds or thousands of pounds on fruitless expenditure. Any crop which will succeed fairly well on "bad" land is particularly valuable—most crops succeed on good land. Moreover, when fair crops, especially of leguminous plants can be grown, the whole farm is enriched, more animals can be kept, and more farmyard manure produced. Heavy crops also leave an abundant root and leaf residue, and their numerous fibres greatly improve the texture of the soil. This applies to all crops, but most to those with an extensive root system.

Those who come into occupation of land in a poor state of fertility will do well carefully to choose the crops to be grown during the first few years. Most farms which have been "run out," have had little farmyard manure produced on the place recently. Artificials may be a great help by increasing the quantity of straw and forage available. These enable more live stock to be kept and in consequence mean more farmyard manure. Leguminous crops are extremely valuable in building up fertility and as a rule some of them will thrive on heavy land if phosphates are used generously and the land is adequately manured and drained. On light land, lime is often lacking and must be provided, especially for leguminous crops, barley and sugar beet. Nitrogenous manures have a great effect in increasing the quantity of straw on all types of land, and this, being used for litter, means more farmyard manure.

An inexpensive and effective way of building up fertility on heavy land is to use temporary leys containing a large proportion of clover. Leys are also valuable on light land, but should usually include a good proportion of lucerne and other deep-rooted plants to withstand droughts.

In seed-growing districts, poor clay fields at a distance from the homestead have sometimes been put down to wild white clover for seed and have thereby become greatly enriched and have also proved profitable to the farmer. On heavy land vetches, and on light land lupins, are valuable owing to their capacity to thrive under rather poor conditions of fertility.

Of the cereals, rye is valuable on poor light land, whilst both rye and oats will grow on land which lacks lime. Lupins, essentially a poor light land crop, are the only leguminous crop which will thrive on land needing lime. On poor land containing sufficient lime, trefoil is quite useful in building up a measure of fertility, whilst owing to the early date at which it is folded or removed, much of the summer remains in which a fallow can be made, or a catch crop, such as turnips, grown.

Stacking and Thatching.

The shape and size of stacks differ very much in various parts of the British Isles. As a rule, large rectangular stacks are made in the drier arable districts, and where a large bulk of corn has to be dealt with. In a wet harvest, those who normally erect very large stacks sometimes follow the example of their fellow farmers in wetter districts and make smaller stacks as these allow the corn to dry a great deal in the stack. Grain which has to be stacked in a somewhat damp state is much less likely to take harm if put in a small and narrow stack especially if the stack can be placed in a windy position. In northern districts, small round stacks are the rule.

When the material is not in very good condition ventilation shafts can be arranged in stacks. Hurdles arranged in "A" shape through the stacks are good for this.

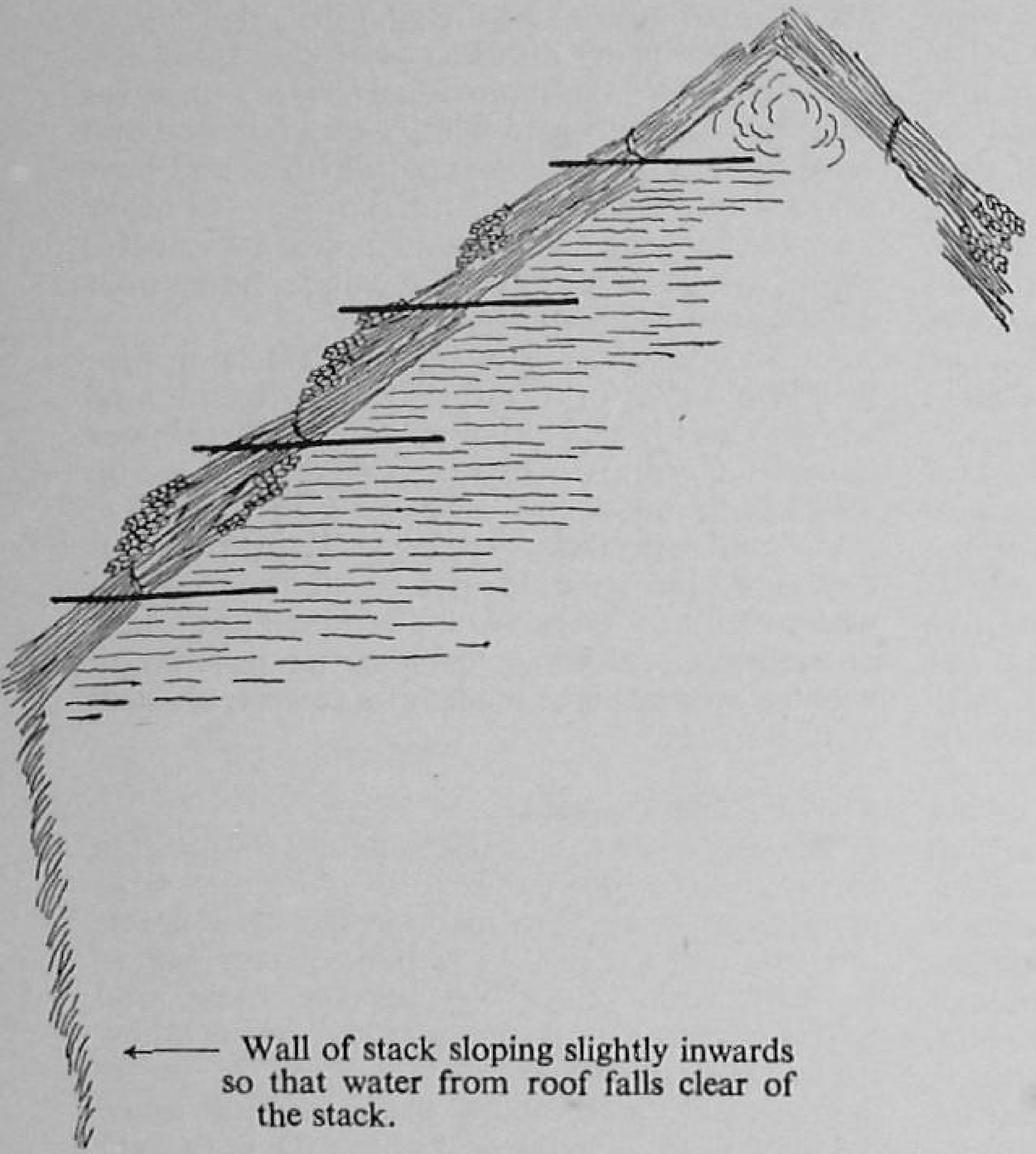
A sack full of chaff drawn upwards as the stack is erected, is also used to leave a kind of chimney up the stack. Faggots placed across the stack also permit air to draw through and help to dry the contents.

Before beginning to erect a stack it is important to see that the site lies high and dry and that a substantial "stack bottom" or "staddle" is arranged to keep the grain from any dampness.

For this purpose waste material from hedges, logs of wood and then plenty of straw are commonly used. When starting to make the stack a large shock of corn should be erected in the middle of the staddle and sheaves piled round it so that all ears are off the ground.

In erecting a stack it is very important to keep the middle full, in order to cause all straws to slope downwards and outwards and the middle should be kept very full whilst roofing. As a result of this, any rain which gains access to the roof through the covering will tend to run off instead of soaking into the stack. These precautions are not so necessary when the stack can be put under a Dutch barn.

All stacks in the open should receive a good coating of loose straw on the top, whatever method of covering it is proposed to adopt. An examination of the roofs of hay stacks which have not been covered up in this way nearly always reveals an appreciable amount of hay which has gone mouldy.



Cross section of stack covered by "battens" of straw. The batten at eaves is put "Butt" end downwards, the others butt end upwards.

In the case of stacks of sheaves those sheaves on the ridge are nearly always spoiled in some way; either by birds before thatching or by wet. Hence it is sound policy to put plenty of loose straw on the top. This should be held down by strings passed over the stack, and attached to poles or other heavy objects.

Thatching and Protection of Stacks from weather.

Large Dutch barns, i.e., roofs on uprights, under which the stacks can be erected—are most useful and efficient. They, however, result in a large quantity of corn or hay being stored in one bulk and hence increase danger from fire. Only a comparatively small proportion of our harvest is stored under these erections as they are relatively few in number.

If no Dutch barn is available, the stack should be protected from rain as soon as possible after erection. From time to time very heavy rain falls immediately after harvest. In late August, 1912, seven inches of rain fell in one day in parts of East Anglia, and many newly-erected stacks were wet through and had to be taken to pieces to dry.

In the autumn of 1942, great loss occurred to stacks in some districts owing to rain falling before they were covered.

Thatching.

Thatching is the time-honoured method of covering stacks in the open. In some districts it is carried out by those normally working on the farm, whilst in others specialist thatchers do the work. In wind-swept areas particular care is taken in roping down the thatch. The details of thatching also differ to some extent in different districts. Scarcity of skilled thatchers, with the very much larger number of stacks to be covered has, during the second world war, attracted much attention to quicker methods of covering stacks, which may be briefly mentioned.

"Batting or Battening."

This is practised in the Midlands. Most travelling threshing machines take round with them a straw-trusser which ties the straw into sheaves or "battens" as it comes from the drum. It is important that only one string should be used round each sheaf and that the straw should come from a crop of wheat or rye which had stood erect. The battens, after lying in the straw stack for a few months get flattened out. Immediately a stack is erected a man on a ladder places the battens on the roof, like slates on the roof of a house. Thatch pegs, used to fix the bats into the stack, should be inserted in

such a way that they slope slightly downwards and outwards. If this is done the wet does not follow the pegs into the stack. Two men can cover a stack on a base 11 yd. by 5 yd. in 5 hours or even less. The covering is not quite so efficient or permanent as thatch, unless it is very carefully done; but the work can be carried out in from a half to a third of the time; this depending on the speed of the local thatchers.

Loose Straw.

Much can be done by the use of plenty of loose straw to temporarily protect stacks—in fact whatever method of covering is finally adopted, it is best to put a good deal of loose straw on the ridge.

If a roof is made not quite so steep as usual and thatch pegs or broaches are put near the eaves, a wagon load of loose straw may be judiciously shaken out on to the roof in such a way as to turn a great deal of rain. The man doing this must not trample on it afterwards. After putting it on, the loose straw will of course be fastened down by cords over the roof attached to weights. A combing down by means of a rake or fork will set the straw in the downwards direction and help to run the rain off.

A farm elevator enables a load of loose straw to be put on the top of a stack, with very little expenditure of time or energy.

Waterproofed paper and stitched thatch were advocated by some during the 1939–45 war, as a rapid means of covering stacks, but neither of them appears to have become established in ordinary farm practice, to any great extent.

A Batt or Batten of Wheat Straw tied up direct from the drum, at threshing time, ready for covering stacks.

CORN CROPS—WHEAT

Beginning his consideration of corn crops with wheat, our author defines climate and soil conditions for this cereal. He shews how to prepare the land and deals with the subjects of varieties, under the headings of Autumn-sown Wheats and Spring-sown Wheats. The manurial treatment is then discussed in relation to soils of different textures; top-dressings are explained. Details about sowing the seed are given, as well as directions for the care of the plant during growth. Harvesting and Threshing are dealt with briefly, and in conclusion mention is made of utilization, quality, area and yields.

WHEAT.

" Food is a very real munition of war, even more vital than tanks, aeroplanes and guns."—*Sir E. Appleton, on the Wireless, February*, 1943.

The Origin of Wheat.

Of the various plants cultivated by man, none is so important as wheat. In a large part of the world it provides him with bread. In the British Isles it is one of the four cereals commonly grown; the other three being oats, barley, and rye. The very name Cereal—derived from the goddess Ceres, indicates the importance of these grains to the ancients, as to modern man. Strangely enough very little is known of the origin of wheat. We know that a wild wheat has been found in Palestine, but who first cultivated it and " domesticated " it history does not tell us. The ancients, however, ascribed this beneficial work to the gods—Osiris, Demeter and Ceres.

Primitive man must have had a terrible struggle to live before he began to cultivate the soil and grow crops to eat. Words cannot express our indebtedness to those, our far-off ancestors, who first grew corn for food.

Climate and Soil.

Wheat is one of the most hardy of cultivated plants and will grow under very different climatic conditions. A large number of varieties exists—some will ripen in the short summer of northern Canada—whilst others succeed near the Equator. In spite of this, however, the more northern and wetter districts of the British Isles are not very suitable for growing the varieties we have at present.

The high-lying districts of the Pennine Chain, of Wales, Scotland and Ireland do not permit wheat to ripen properly, especially when, as is often the case, high altitude is associated with heavy rainfall. The eastern, midland, and southern parts of England are extremely well suited for wheat, and the eastern and midland parts of Ireland grow heavy crops. Good crops of wheat are also grown in the drier and more easterly parts of Scotland.

Wheat will grow on a very wide variety of soils. The heavier the soil the less rain the crop requires. On really heavy soil wheat seldom suffers from drought, in fact, it is in the warmest and driest summers that we usually get our best yields on such soils. On lighter soil wheat will thrive with—and in fact requires—a much heavier summer rainfall, while on really light soil, in a dry season, it may suffer severely from drought. As a rule, very wet winters adversely affect the following wheat harvest.

On heavy soil it is absolutely necessary that adequate drainage be provided. Wheat will not produce a satisfactory crop if the land is waterlogged at any period during its growth. Given suitable drainage, wheat is capable of giving good yields on the stickiest and most intractable of clays, provided enough manure is applied and skilled tillage is given. With irrigation, good crops of wheat could probably be grown on our lightest soils, in our driest areas.

Place in Rotation.

We have already noted that wheat often follows a leguminous crop—peas, beans or clover—in the rotation. Wheat may, however, be grown after a variety of other crops. As previously mentioned, wheat may be grown after wheat for a very long time and has been so grown for a hundred years at Rothamsted; but the land tends to become exhausted under these conditions because no crop is grown to enrich the soil, and very little opportunity is afforded to clean the land, since the interval between harvest and seed time is so short. It also encourages disease, such as Eyespot and Takeall which may be very serious.

Wheat is quite frequently and successfully grown after potatoes and mangolds, and often then gives good crops. It may even follow swedes or sugar beet, if these can be removed in time to sow the wheat.

Spring wheat may follow almost any root or green crop which is removed in time for spring seeding.

Wheat may also follow barley or oats; where, however, it follows a cereal, it must be generously manured, or a good crop cannot reasonably be expected. Wheat after barley tends to encourage the fungus disease " Takeall." During the two great wars it was quite frequently put in as a first crop after grass. Sometimes the grass was broken up during the summer, the grass killed and the land fallowed, wheat being put in during the autumn. Sometimes again the land was merely ploughed in late September and early October, and the wheat drilled almost at once. Some skilful farmers have obtained good results with wheat after grass, but there have been many failures. After broken-up grass, the land often lies light and hollow—this is exactly the condition which does not suit wheat.

Very often also, grass land contains many

wire-worms, sometimes more than a million per acre. These insects, the larvæ of the click beetle, live for several years in the soil and may do immense damage to the crop, especially to cereal grains.

If it is desired to grow wheat after broken-up grass special care must be taken to get the land thoroughly consolidated and adequately manured (if manure is necessary). It must be recognized that whoever gets a good crop of wheat as a first crop after broken-up grass is specially skilled.

Preparing the Land.

Where wheat is to follow peas, beans or a cereal, the modern farmer, especially after an early harvest and in dry weather, endeavours to cultivate the surface of the stubbles with a tractor cultivator. The object of this is to drag up surface weeds and to cause weed seeds to germinate. Then the land is ploughed in two or three weeks, say during the latter part of September or early in October, and the seedling weeds will be buried and so killed. The after-harvest cultivation of stubbles is more often possible in the southern parts of Britain than in the north, and on light or medium loams than heavy soil. In the north, harvest is usually too late to permit much autumn cultivation.

Where wheat is to be grown after clover or "seeds," i.e., temporary grass and clover mixed, the land is frequently merely ploughed, especially where a second crop of clover has been taken.

Sometimes the "seeds" may be left down for two or more seasons. When this is done it is quite a good plan to graze them in the last year until the middle or end of June, and then break up by plough or cultivator and give a "pin" or half fallow to kill weeds. In this case the land is pulled about a number of times by implements drawn by tractor, steam-power or horses, during July and August.

The clods get baked by the sun in a dry year and it is then possible to kill most, or all of the *twitch* or *couch-grass* present. Even if the weather in July or August proves showery, much good is done. Millions of weed seeds germinate and are killed and the land is exposed to the weather. No doubt also many insect pests are eaten by birds. In this case the land is finally ploughed about the end of September. Leaving the land bare in July and August unfortunately renders the wheat liable to attack by wheatbulb fly. Wheat appreciates solid or firm land, hence if the land is not in this condition, means must be taken to consolidate it. The land press, which is fixed behind the plough, is a most effective way of doing this, but in some districts there are very few of these. Cambridge or rib rolls and ordinary rolls are very useful whilst under certain circumstances disc harrows not only work up a good tilth, but also consolidate the land. Where grassland is ploughed up in early October with the idea of drilling wheat almost at once, the disc harrow is a most valuable tool.

Varieties.

There are large numbers of varieties of wheat—some of these are very old, whilst others owe their origin to the work of agricultural botanists during the past 40 years or so. In this country no one has done more valuable work in improving wheat than Sir Rowland Biffen, fomerly Professor of Agricultural Botany in the University of Cambridge. Professor Biffen found by the discoveries of Mendel, that it was possible to introduce certain definite qualities into the plants

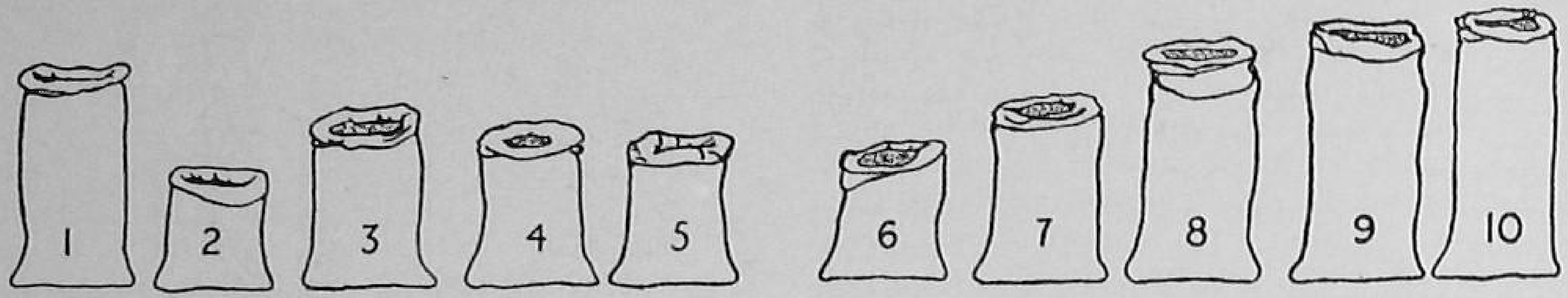
Spring Wheat.—Showing the importance of selecting a variety which will mature if sown late. Both these varieties were drilled side by side on March 29th, 1942. Hybrid 29 failed to produce any appreciable number of ears.

which he desired to breed. Thus into the wheat "Little Joss" he introduced the quality of resistance to the fungous disease known as "rust." Subsequently he bred "Yeoman" wheat which produces a "strong" flour capable of making a well-piled and light loaf. Yeoman was followed by "Holdfast," perhaps of even higher quality grain.

A few of the most valuable varieties of wheat may now be considered—further information regarding varieties of farm crops may be obtained in the valuable leaflets issued by the National Institute of Agricultural Botany, Huntingdon Road, Cambridge.

Autumn Sown Wheats.

Wilhelmina and the similar Victor, Wilma and Juliana are most reliable high yielding wheats on good heavy soils and on light soils in districts of fairly heavy rainfall. The grain is white and the straw fairly short. In a wet harvest the grain very quickly grows in the shock or stook. Little Joss is a suitable variety for light soils. The grain is " red " and the straw long and apt to become laid on good soil. Steadfast is also a light land wheat. Yeoman succeeds best on really good land or where the soil is heavily manured. The short straw helps it to stand up. The grain is red and of high milling quality. Holdfast is very short in the straw and is recommended for land in the highest state of fertility. The grain is white and a high milling quality. Redman and Warden are suitable for good land and are of high milling quality.



Wheat from Saxmundham Heavy Land Experimental Station.

Each plot has received the same manure every year for 40 years, but has been cropped in rotation:—Wheat, mangolds, barley and leguminous crop.

Plot (1) 6 tons Farmyard Manure.
„ (2) 4 cwt. Bone Meal.
„ (3) 2 cwt. Nitrate of Soda.
„ (4) 2 cwt. 30 per cent Superphosphate.
Plot (5) 1 cwt. Muriate of Potash.
„ (6) No Manure.
„ (7) 2 cwt. Super; 1 cwt. Muriate of Potash.
Plot (8) 2 cwt. Nitrate of Soda; 1 cwt. Muriate of Potash.
„ (9) 2 cwt. Nitrate of Soda; 2 cwt. Super.
Plot (10) 2 cwt. Nitrate of Soda; 2 cwt. Super; 1 cwt. Muriate of Potash.

Note the beneficial effects of Farmyard Manure, Plot (1), and of Nitrate and Superphosphate together, Plot (9).

Swedish wheats (Iron, Steel, etc.) were introduced by the Swedish Plant Breeding Station. They are rather late in ripening with stiff straw and red grain of rather inferior milling quality. They give heavy yields of grain on good soils.

Pilot is a somewhat similar wheat, but is claimed to give higher yields, of better quality than the Scandinavian varieties.

Bersée and Jubilégem have been found to give heavy yields on good soils.

Squarehead's Master is an old variety of red wheat which is still widely grown on average land. As a rule, it is probable that varieties may be chosen which will out-yield it on any particular soil. Rampton Rivet is a good selection of the old English variety, Rivet, and is suited to heavy soils of low fertility. The straw is very long and strong and the ears are bearded. The grain is red and of inferior milling quality. Rivet wheats ripen 10 days or so later than most other varieties.

Spring Sown Wheats.—As a rule spring wheats do not yield so well in this country as do winter wheats. Of late years certain varieties have been introduced which are superior to those formerly available. Some varieties of winter wheat may be sown in January or even up to mid February. Amongst these may be mentioned Little Joss, Yeoman, Holdfast and Squarehead's Master and Bersée. *For mid February to the end of March* the following may be sown. *Atle*—A Swedish variety which usually has out-yielded Red Marvel. The straw is short and the grain small, red and of high baking quality. It is probably the best spring variety we have in this country for sowing on good wheat land where there is risk of lodging. *Extra Kolben II* has given good results in Suffolk. It has red grain and rather thin straw.

Blanka, a swedish variety, with white grain, has out-yielded Red Marvel. It is not suited to rich land.

Hybrid 29 is not a true spring variety and when sown at the end of March, it has sometimes failed to ripen satisfactorily. When sown in February on very good land it has succeeded well. *Meteor*, a variety which stands up well, has given good yields. *For April sowing*—April bearded is suitable on soils of low fertility; Fylgia on better soils. Further details regarding varieties of wheat are given in leaflets published by the National Institute of Agricultural Botany.

Manuring.

The manurial treatment of wheat has been studied for a hundred years at Rothamsted and in rotation with other crops for 49 years at Saxmundham experimental station in Suffolk. Experiments have also been conducted on a number of farms in various parts of the country. In the space at our disposal it is impossible to consider details of these experiments.

Suggestions as to suitable manuring.—Farmyard manure ploughed in at the rate of about 10 tons per acre, if available. Where farmyard manure

is not available a greatly increased crop of wheat may often be obtained by the use of suitable artificials, as follows:

On Heavy Land.—3 cwt. Super or 4 cwt. Basic Slag, applied before working the land down previous to drilling.

On Lighter Land.—1 to 1½ cwt. Super; ½ cwt. Muriate of Potash, mixed together and applied before working the land down previous to drilling.

When the preceding leguminous crop has received a good dressing of phosphates, either as super or slag, it will frequently be hardly necessary to make a further application of this material. Where a combine drill is used artificials of suitable texture must be available.

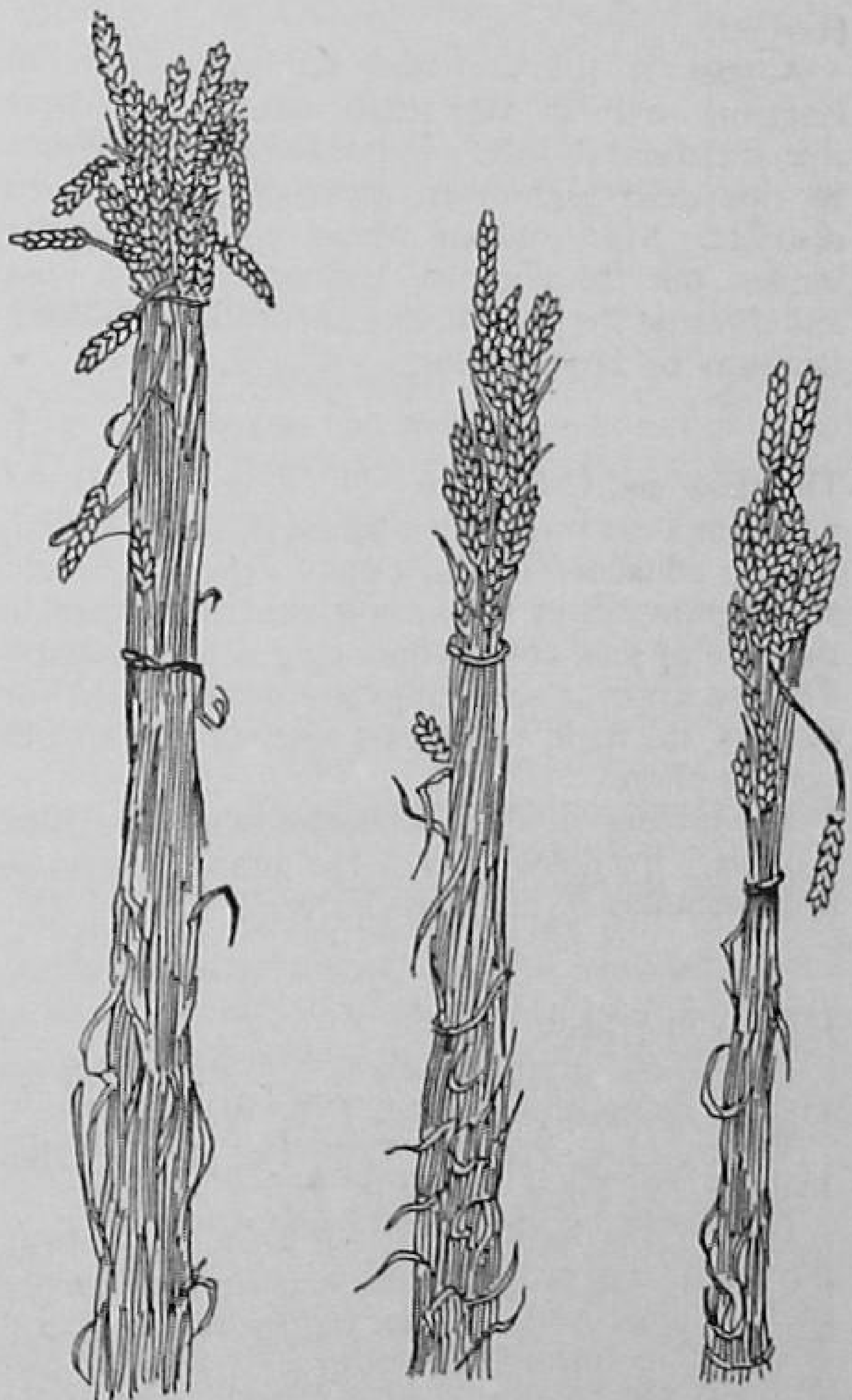
Top Dressings.

In spring, nitrogenous manures should be applied as top dressings unless it is probable that a full crop will be obtained without. The crop aimed at should be one which will stand up at harvest in an average season, and the quantity of manure used should be regulated according to the "rankness" of the land. If the wheat needs generous help, apply ¾ cwt. to 1 cwt. sulphate of ammonia as early in March as possible, followed by a similar quantity about the end of April. Nitrate of soda or nitrate of lime or "Nitro-Chalk" may be used instead of sulphate of ammonia at a slight heavier rate per acre and, being quicker in action, may be applied a little later in spring. These manures should always be used in preference to sulphate of ammonia when the land is poor in lime. A single dressing of nitrogenous manure applied in spring if it is noticed that the corn does not look very well, may be a great help. Where wheat is grown after a cereal crop a generous dose of nitrogenous manure will nearly always be required.

Sowing the Seed.

For thousands of years man sowed practically all his grain broadcast, by hand. The idea of sowing in rows, however, occurred in ancient Babylonia, but this idea has only been adopted on a large scale during the past two centuries. Broadcast sowing of wheat and other grains is still used to a considerable extent in this country especially where there is comparatively little tillage, and, in consequence, the farmers have not the necessary drills. It is also used where bad weather conditions render it impossible to drill the seed. The advantages of drilling in rows are that the seed is covered better, and as a result not only is a smaller proportion eaten by birds but the crop can be horse-hoed and hand-hoed in spring.

Of late years "combine" drills which put artificial manures down the row near the seed have become more general and there is very good reason to believe that this is a considerable advantage for cereals. Where the seed is broadcast this may be done on the untouched ploughing—in this case the seed falls between the plough seam. The land is then harrowed and otherwise worked down to cover the seed. The average quantity of seed wheat used is probably 2½ bushels (4½ stones to the bushel) per acre. Early sowing requires rather less seed than does late sowing. Spring wheat, having little time to branch out and tiller, requires rather more seed. Winter—or autumn-sown wheat may be put in during October, November or even December on the best wheat-growing soil—good heavy loam. The yield of grain is often best with November sowing when conditions are very suitable for wheat. The time of sowing must depend largely upon the weather. A very wet October or a dry October in which the land cannot be ploughed, means a late seed time. It is best to follow the custom of the locality regarding the time of sowing and the quantity of seed per acre.



(9) (2) (1)

Wheat from Saxmundham Heavy Land Experimental Station.

Plot (1) No Manure for 40 years.
„ (2) Farmyard Manure to the wheat every 4 years.
„ (9) As plot (2), but Nitrate to Wheat and Barley and Nitrate and Super to the Mangolds, in the rotation.

Treatment During Growth.

On heavy land, surface drainage is provided by water-furrows and channels cut by spade or shovel, after drilling and harrowing are finished, to let the water into the ditches.

In spring, as soon as the land is dry enough, it should be rolled, harrowed and horse-hoed. Where the land lies rather hollow, thorough rolling is very important to consolidate the land around the roots and check damage by wireworms. Horse-hoeing can only be performed where drilling has been well done. Efficient horse-hoeing destroys millions of seed weeds. Docks, one of the worst of weeds, should be removed by hand, preferably in March and April. Hand-hoeing—a common operation when labour was plentiful and cheap—is not so frequently carried out as it ought to be.

Harvest.

August is the common harvest month in England—only in very early seasons is wheat ripe at the end of July. In late seasons it may not be ripe until September, especially in northern districts. Most of our wheat is cut with the binder, but the combine harvester, which cuts and threshes the grain in one operation, is making headway on larger farms.

Threshing and Utilization.

The modern threshing machine, if carefully fed, is very efficient—it also cleans weed seeds and small grain out of the sample, so that, except in the case of seed corn, winnowing is unnecessary. The tail corn or screenings are usually used for poultry, the main bulk being reserved for human consumption.

The milling of wheat separates what are called "offals," from the flour. The bran, or outside husk contains 10 per cent of fibre.

Quality in Wheat.

The whole grain of wheat has the following average composition (Prof. T. B. Wood):—

Water, 13·4; Protein, 12·1; Fat, 1·9; Carbohydrate, 69; Fibre, 1·9; Ash, 1·7.

Gluten, the most important protein in wheat, possesses the property of holding the carbon dioxide produced in the fermentation of the dough, thus forming a spongy or "light" mass. A wheat which will give a flour resulting in a light, or well-piled loaf, is known as "strong." A "strong" wheat is usually translucent, and a weak wheat, mealy. English wheats differ greatly in this respect. Rivets and Iron, being weak, and Yeoman and Holdfast very strong, producing flour of very high milling quality. The idea, which was promulgated in some quarters, between the two great wars, that English wheat is unsuited for bread-making, is ludicrous.

Area under Wheat and Yields.

In England and Wales we had 3,250,000 acres of wheat in 1870. This fell to 1,337,000 acres in 1904. During the war 1914–18, it rose to 2,500,000 acres, but fell rapidly after that war, and during the 1939–45 war it rose again to a high figure, but fell off after the conclusion of that war. In 1947 it was a little over 2 million acres, in 1948 2,187,774 acres.

The average yield in England and Wales is about 31 bushels. With modern methods of tillage and manuring and the use of improved varieties, very high yields can be obtained even as much as 96 bushels per acre being spoken of. Average yield could be considerably raised by adopting improved methods, especially on the better land. On really poor clay and on light soils it is difficult to get a high average yield; very good yields may be obtained in good years, but the poor yields given in bad seasons pull the average down. Inferior land is more subject to seasonal influences. It is usually wet seasons which result in poor crops of wheat in England, especially on heavy land. Dry winters followed by moderately dry summers, usually result in good crops.

Insect and Fungous Pests.

Wireworm.

The most serious insect pest of wheat is the wireworm, the larva of the click beetle. A crop which is attacked should be rolled with a very heavy roller, and also given a top dressing of nitrate of soda, nitrate of lime or other quick-acting nitrogenous manure.

Modern methods of counting the number of wireworms per acre, give valuable information as to probability of attack whilst B.H.C. (the gamma isomer of benzene hexachloride) has proved very effectual, whether broadcast, drilled in a combine or as a dual-purpose seed-dressing for cereals in combination with organo-mercury compounds.

Fungous Diseases.

Bunt—a seed-carried fungous disease lives in the plant all the growing period. Then when harvest comes the farmer finds that instead of grains of wheat, the chaff is filled with a mass of black fungous spores which have a disgusting smell. If there is a considerable proportion of "bunted" ears in the crop, all the grain may so seriously be contaminated when it is threshed, that it is unfit for human food. This disease can be prevented by seed disinfection (see page 152).

Rust is a disease which attacks the leaves of wheat. Some varieties are more liable to attack than others. Little Joss is almost immune.

The diseases "Take-all" and "Eye-Spot" causing lodging, have been encouraged by growing cereals too frequently in the rotation.

CORN CROPS—*continued*

Oats, Barley and Rye: the cultivation of these crops is considered in detail under such headings as Climate and Soil; Place in Rotation; Preparing the Land; Varieties, Manuring and Lime; Seed-disinfection; Sowing the Seed; Treatment during Growth; Harvesting, Threshing and Utilization; Area and Yield.

OATS.

THE oat plant has been cultivated from very early times, but little is known of its origin. Oats are suited to a more northern climate than wheat. There does not appear to be any evidence that they were cultivated by the Egyptians or the Hebrews, although they were known to the Greeks. They have been grown in the British Isles for a very long time.

Climate and Soil.

Oats succeed in a comparatively moist and cool climate. Scotland, Ireland and Western England are extremely well suited to their growth—perhaps better than eastern and southern England. They will also ripen at a fairly high altitude. In the Peak district of Derbyshire, however, they do not always ripen at a thousand feet above the sea, and where this is the case they are cut for hay. They are suited for a very wide variety of soils and will grow good crops even on very light land—provided there is sufficient moisture. On very light soils, in a dry spring and early summer, they often fail to produce a satisfactory crop. They will grow good crops on really heavy soils provided they can be drilled early enough to avoid the frit fly. Unfortunately this early drilling is very often impossible. Oats, unlike wheat and barley, will grow quite well on a soil which is moderately acid. Extreme poverty of the soil in lime may result in a crop failure.

Oats will often give good crops on peaty soils or on soil rich in organic matter. They have been very widely grown as a first crop on broken-up grass and on light and medium soils they are very suitable for this purpose, especially in a western or northern climate. On heavy land in a dry district and in a very dry spring oats, as a first crop after permanent grass, have often been a disastrous failure.

Place in Rotation.

In ordinary arable farming oats often follow roots or green crops, especially in districts where barley is not much grown or where the soil is unsuitable for that crop. They are very widely grown in Scotland and Ireland after temporary leys. They are sometimes grown after a leguminous crop, when it has been impossible to get wheat drilled. They may also be grown after another cereal, but in this case should be generously manured.

Preparing the Land.

This is comparatively simple as a rule. Where grassland, either temporary or permanent, is followed by oats, it is most important that all the grass should be buried and a skim coulter is the most useful for this purpose. The disc harrow is a very valuable implement to use in working up a tilth and also in consolidating the land and closing up hollow spaces left underneath the newly-ploughed turf. These hollow spaces are undoubtedly one of the causes of the many disastrous failures which have occurred on heavy land when grass has been ploughed up and put into oats as a first crop. Dry weather in May and June has dried out the turf and the hollow spaces have prevented the roots of the oats from reaching the subsoil moisture. This is more likely to happen on stiff soil ploughed late in spring than on lighter soils, since the turf of the heavy soil hangs together more. In districts where oats are sown broadcast the seed is merely sown on the plough seam, into which it falls; it is covered by repeated harrowings. Where oats follow a root, green or leguminous crop, a single ploughing is usually all that is necessary before seed time.

Varieties.

There is a very large number of varieties of oats grown in the British Isles. For details regarding these the reader is referred to "Oats," by H. Hunter, D.Sc. (E. Benn, Ltd.). It may be mentioned, however, that oats may be divided into two classes—straw producers and grain producers. The former produces a larger proportion of straw to grain than the latter. Whilst a very large proportion of the oats grown in this country is spring sown, we have every year a certain area sown in the autumn—known as winter oats. These are hardy and able to withstand the ordinary winter of the districts in which they are grown. Most varieties of oats are white in colour, but some are yellowish, grey or black. Varieties differ in the shape of the panicle "head" or "ear"; in some cases this is bell-shaped, whilst in others the grain is carried on the side: these are known as side-bearers.

Straw Producers.

Most of the old kinds belong to this group. They are mostly suited to districts of heavy rainfall or high altitude and often rather poor soil. They have good tillering powers (i.e., each plant will branch out at the base) and the straw is long and likely to become laid. The straw is usually of good quality for feeding to cattle, whilst the grain is of high milling quality. They usually produce a large bulk of straw and not a very high yield of grain per acre. Of old varieties suitable for mountainous or poor and exposed districts, Sandy oats may be mentioned. They were introduced by a herd-boy named Alexander Thomson, in Aberdeenshire in 1824. Sandy

noticed an oat plant of distinctive character and raised a stock of it. It was named after its discoverer.

The Potato oat, one of the most famous varieties, was introduced by a labourer in Cumberland who noticed a distinctive oat-plant growing in his potato patch. The potato oat produces grain of very high quality and fairly abundant straw of good feeding value. It has been grown very extensively in Scotland and Ireland. Under really good conditions the yield of grain per acre is inferior to that of the grain-producing oats, even under northern and western conditions. In the east, midlands and south of England this, like all other straw-producing oats, is practically unknown. In Wales, there are local varieties suited for high-lying conditions. The Welsh Plant Breeding Station has also introduced or called attention to several oats suitable for poor upland soils, such as S.75 and S.171. Particulars of these are given in the bulletin *Cereal Production* (The Welsh Plant Breeding Station). The National Institute of Agricultural Botany, publishes a valuable leaflet on varieties of Spring Cereals.

Grain Producers.

In the low-lying districts of the British Isles these varieties are generally found to give heavier yields of grain than straw producers. Most of these oats have their origin in the work of the agricultural botanist. The Swedish, Cambridge, and Aberystwyth Plant breeding stations having produced valuable kinds, as have also various seedsmen. Eagle, Victory, Star Milford and Onward are white oats, which must be regarded as amongst our best varieties for ordinary fertile land. Of these, Eagle and Onward have given slightly the best results in the trials of the National Institute of Agricultural Botany under English conditions. Resistance, a white oat, may be sown in autumn but is not truly winter-hardy. If it can be sown very early in the new year it is suitable for highly fertile soils where other varieties would lodge. Abundance, which has been grown very widely in the past, is not equal to Victory and Eagle in yielding capacity. Aberystwyth S.84 gives high yields on fertile soils and in districts of late summer rainfall. In Wales it has been found to stand up well.

Winter Oats.

These differ in their capacity to resist really severe winters. Grey Winter is most resistant, but the straw is weak and liable to lodge. Black Winter is not so resistant. The straw is a little stronger. Aberystwyth White Winter S. 147, stands well and is suitable for good soils, but is not so frost-resistant as Grey Winter. Picton, a white variety bred by Dr. H. Hunter, has stronger straw than Grey Winter and out-yielded that variety and is almost as winter hardy. Aberystwyth S. 81 and S. 172 are white oats, strong strawed and suitable for good land. They are winter hardy. In normal winters S. 172 is suited for very fertile land. It, and S. 81 and S. 147 were bred by Mr. E. T. Jones.

Manuring and Lime.

Oats will grow satisfactory crops on soils which are lacking in lime, in this respect differing widely from barley and wheat. Certain soils are too acid even for oats and the crop may then be adversely affected or even fail. The manuring of oats depends largely upon what was the previous crop. Where oats are grown after a heavily manured root crop they may not need any manure. This is also the case where they are grown after temporary or permanent pasture of a good type, especially where it has contained an abundance of wild white clover. After poor pasture, a suitable dressing of artificial manures may be very helpful, and may double the crop. Where oats are grown after another cereal, or where it is known that the land needs help, artificials should be applied. On heavy land where a combine drill is available, a fertilizer in suitable physical condition containing nitrogen and phosphates should be used. On light land the fertilizer should contain, in addition, a little potash. Where no combine drill is available the following are suitable:

Spring Oats.

Heavy and Medium Land—

1 to 1½ cwt. of sulphate of ammonia 2 to 3 cwt. superphosphate (30%) per acre.	Mixed together and applied before working down the land.

Light Land—

1 cwt. super (30%) . . ½ cwt. muriate of potash per acre	Mixed together and applied as above.

Then 1 to 1½ cwt. nitrate of soda or lime or "Nitro-Chalk" applied a week or two after sowing.

Winter Oats.

2–3 cwt. Super (30 per cent), before working the land down in autumn or in a combine drill. In the spring 1 to 1½ cwt. sulphate of ammonia in March, or 1 to 1½ cwt. nitrate of soda or "Nitro-Chalk" in April or early May.

Seed Disinfection.

Oats are subject to certain seed borne disease—smuts and leaf stripe.

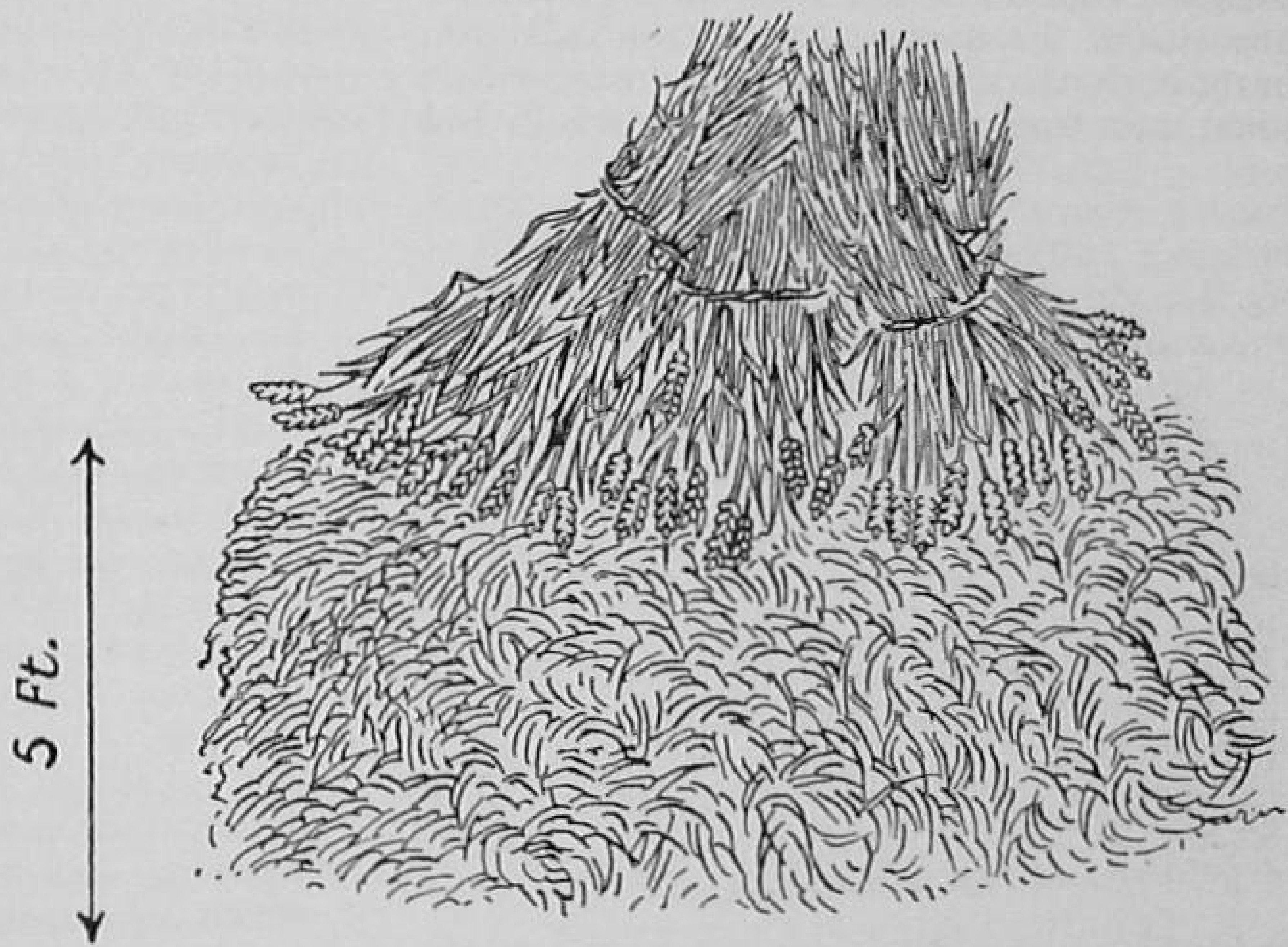
These can be kept in control by disinfecting the seed with organic-mercury seed dressings. The object is to ensure that each grain is coated with the powdery disinfectant. (See pages 152 and 170).

Sowing the Seed.

In the principal tillage districts of Britain, corn

drills are always used for oats. They require less seed than is used when broadcasting, since the grain is more completely covered. Oats, however, are largely grown in high-lying districts, in which there is little tillage, and where there are comparatively few implements. In such case the ancient method of broadcasting may be adopted, and there is no reason why excellent crops should not be obtained from it. Where drilling is to be adopted the farmer waits until the land is dry enough in early spring and then works it down by means of harrows. He then drills the grain and covers it by harrowing. The actual date of sowing spring oats varies according to season and district. In the southern part of England, many farmers would drill oats in January if the land were dry enough, but very often they have to wait until March or even April. The latter month, which is so late as to greatly endanger the crop in the south, is quite usual further north and in hilly districts. The importance of drilling early in the south, midlands, and east of England can scarcely be over estimated.

In these districts that great pest of oats, the frit-fly, almost always attacks late sown oats. Dry weather frequently occurs in April and May and this is particularly bad for oats sown late, especially on heavy or rather cloddy land. The quantity of seed necessary per acre is considerably different in different parts of Great Britain. This also depends on the size of the grain, which differs greatly with different varieties.



A hand-stack of corn, protected on the top by sheaves. Hand-stacks are useful in wet districts, as corn may be put into them temporarily and then carted to a larger stack after a week or two, during which time moisture is lost if drying winds prevail. They are especially useful when there is clover in the "butt" ends of the sheaves.

In the south, eastern and midlands districts of England the average quantity is probably about 4 bushels per acre. In Scotland the quantity required is greater. Experiments conducted by the West of Scotland College of Agriculture shewed that about 3,000,000 germinating seeds per acre were required when potato oats were broadcast—equal to about 5 bushels. If large grained varieties such as Victory are used, then 7 bushels would be required to supply this number of seeds. Evidently also the quantity of seed per acre depends upon the percentage germination. This point can easily be tested by planting 100 seeds in a flower-pot or by sending a sample to an official seed-testing station. After a wet harvest the germination of seed grain is apt to be worse than its appearance would indicate, and sometimes the vigour of germination may be reduced so that feeble seedling plants are produced. Disinfecting the seed with mercury compound probably helps in obtaining a good plant by destroying moulds and other organisms which attack the seed after sowing.

It is, however, a great mistake to sow seed which has been weathered in harvest if this can be avoided.

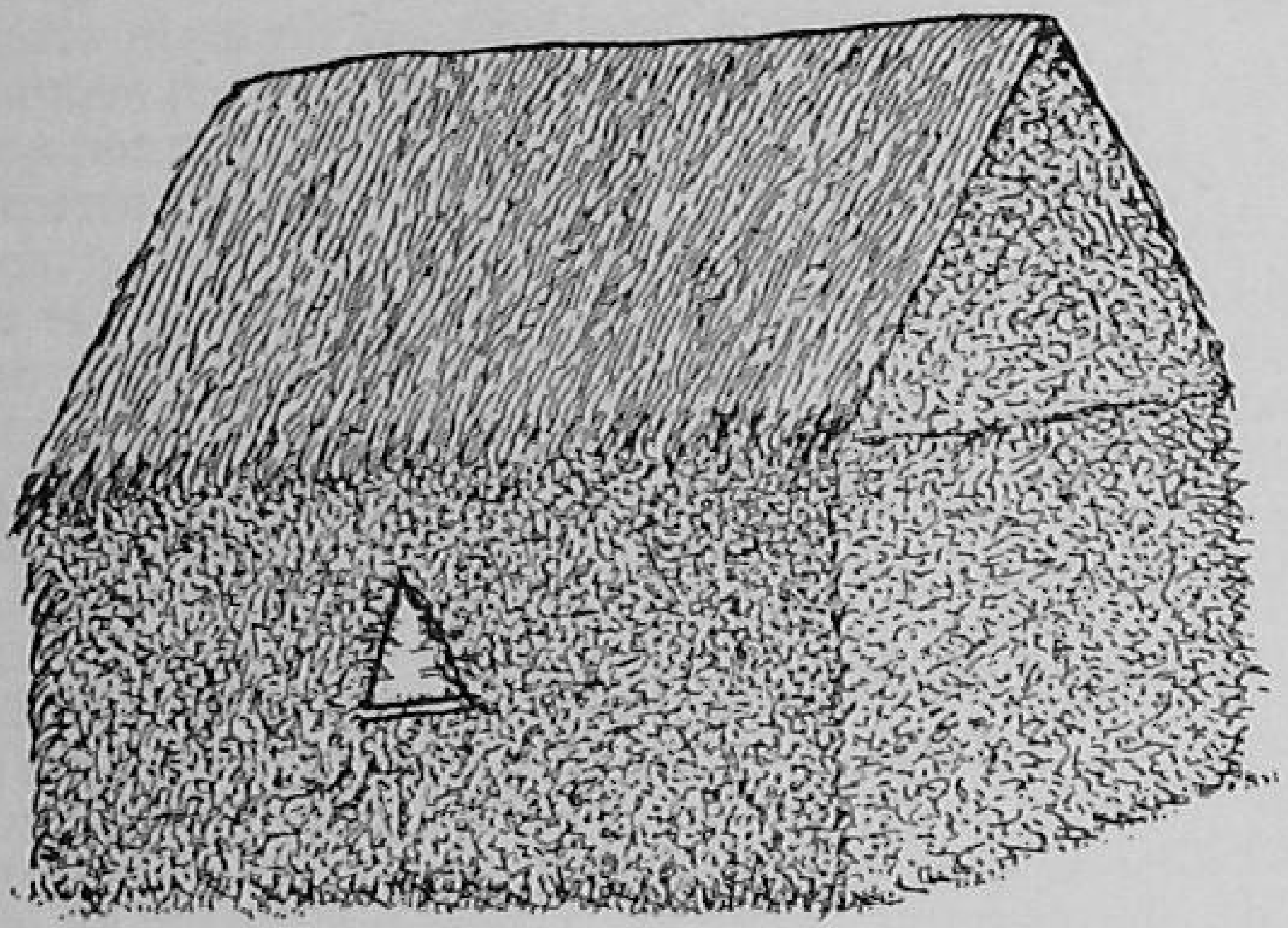
Treatment During Growth.

Where oats have been drilled in straight rows they may be horse-hoed—this kills a multitude of weeds. Oats, however, are more easily damaged by horse-hoeing than are other cereals. Where the oats have been broadcast, horse-hoeing is impossible, but the larger weeds—docks, thistles, etc., may be removed by hand. Charlock and other weeds may be killed by spraying (see Tillage and Weeds, page 159).

Harvesting.

Oats are, if possible, cut when the grains are fairly hard. In some seasons the straw may be green when the grain is ripe—this is often the case after attack by frit-fly. In tillage districts oats are practically all cut with the binder, but there are many oats grown in high lying places where modern machinery does not exist and these may still be cut with the scythe or back-delivery reaper. In dry districts oats are shocked like wheat, but in late or wet places greater care must be taken to protect the shocks by heading them with sheaves or battens of straw. An alternative plan is to make hand stacks and double

shocks or stooks. These are erected after the oats have been in shock about a week when the butt ends and internal part of the sheaves still contain sap and moisture and perhaps green stuff. The tripod and four-pole systems of harvesting are also gaining ground (see Peas, p. 180). In all districts oats require more "field room" (i.e., more time after cutting) before they are fit to cut than do wheat or barley. The straw is of different nature—more inclined to heat in the stacks if not thoroughly dry. In good weather oats may be fit to cart in 10 days or even less. In a wet harvest they are more likely to take harm in the field than is wheat. In dry districts oats are usually made into fairly large stacks, but in the north and west small circular stacks with a circular base are adopted as these give more opportunity for the crop to dry in the stack. In the midlands in wet seasons much grain which could have been saved if northern methods had



Oats.—Showing ventilation passage arranged through the stack by means of hurdles arranged in a triangle. When any grain crop has to be carted before it is thoroughly dry, a ventilation passage permits air to draw through the stack and helps the grain to dry.

been adopted is spoilt in the field. As with wheat, it is very important to put a good roof on an oat stack, the middle being kept well full. If rain falls before the stack can be covered more harm is done to oats than to wheat, hence the system of "batting" described under "Stacking and Thatching" is extremely useful as a temporary cover.

When grain has to be carted in not very first class order, damage in the stack may be reduced by building in ventilating shafts with faggots or hurdles fixed in triangular form throughout it to permit air to circulate through the stack. Small and narrow stacks are also a great advantage as they reduce risk from heating and mould.

Of late "Combine harvesting" of oats has become increasingly common, their straw being baled.

Threshing and Utilization.

It is usual to thresh oats from the stack during the winter when the straw is required by the cattle. An appreciable proportion of the oats grown in this country are intended for cattle or horse food, but a large quantity is used for milling and the preparation of rolled oats or oatmeal for human food. This proportion is much higher in time of war and demands the highest quality oats. Scotch oatmeal and flaked oats are world-famed, whilst oats grown in certain parts of Ireland are also excellent for human food. The climate of Scotland is more suitable for the production of milling oats than is that of parts of England. A good average sample of oats grown in Scotland may contain 12 per cent of protein and 7 per cent of oil with 60 per cent carbohydrates, 9 per cent of fibre and 2·75 per cent of ash.

In a bad oat year the composition of English oats with many grains attacked by frit-fly, may be poor. The proportion of husk to kernel differs considerably. A thin-skinned variety like Potato oats may give 76 per cent of kernel and 58 per cent of meal, whilst a thick-skinned kind might have only 65 per cent of kernel and 50 per cent of meal.

As a rule, in England, the differences in the nutritive value of oats in accordance with the thickness of skin and freedom from grain-damage due to frit-fly, are hardly realized.

Oatmeal may contain 15 per cent of protein, 8 per cent of oil and 65 per cent of carbohydrates. The digestibility is high. Its great value as a human food will be realized from this. Actually oats are the only home-grown grains which contain a good proportion of oil. Porridge and milk combined form a food which can hardly be excelled from a nutritive point of view.

For cattle food, oats are usually crushed and fed in conjunction with beans or peas, or some other food high in protein. By this means a "balanced" ration of concentrated food can be obtained. Such a mixture has been found excellent for feeding to cows for milk production.

Straw.

Good oat straw is very valuable as fodder. One lb. of straw plus 2 lb. of kale is equal in food value to 1 lb. of hay.

For many years it has been the custom to chaff oat straw at the time of threshing. It is then mixed with pulped roots and fed to cattle. It is doubtful whether the extra labour and expense of chaffing is justified. If cattle are fed straw in its long state, they pick out the best portions and reject the tough and woody material which is of little food value. If the straw is chaffed they are obliged to eat the whole—good and bad—and digestive troubles are more likely to follow. The value of oat straw differs considerably according to the

district in which it is grown and the variety of oats.

Straw Pulp Process.—In this process chopped straw is soaked for 12–22 hours in caustic soda of about 1½ per cent strength, after which the soaked chaff is drained and exhaustively washed in running water until perfectly free from alkali. The residual straw pulp is fed to live stock in the wet condition.

This process, strongly recommended by some, during the 1939–45 war has not become part of common farm practice, probably because of its cost in labour and material.

Area and Yield.

Partly owing to their suitability to the climate of Scotland and northern England, oats occupy a larger area of the British Isles than any other cereal. The average crop is about 40 bushels per acre, but crops of 100 bushels or even more, have been obtained. Under high farming conditions 80 bushels per acre is not an unusual yield. From 20 to 40 cwt. of straw may be obtained.

Barley

Barley was cultivated by the Egyptians thousands of years ago. It was used as human food by them, and in Palestine in the time of our Lord, five barley loaves having been used at the feeding of the five thousand (St. Mark, vi. 38).

Climate and Soil.

In Great Britain barley is best suited for the drier and warmer part of the country and flourishes on light and medium loams containing sufficient lime. It is adversely affected by acid soils (i.e., those lacking lime) and may fail completely if the acidity goes beyond a certain point. Although light loams suit it best, it will grow abundant crops although not of the best quality, on really heavy soils. It will also grow on light sands, provided there is sufficient rainfall. On the light sands of East Anglia, in a dry season, it may fail to come out into ear.

Place in Rotation.

Normally barley is grown after a root or green crop. It will, however, succeed well after another cereal, either wheat, oats or barley, provided sufficient manure is applied. It is probably better suited than either wheat or oats for growing after another cereal, one reason for this being that it need occupy the land a relatively short time. Also it does not require so much nitrogen in the soil as do the other cereals.

Preparing the Land.

The land is ploughed after the root crop is removed or fed to sheep. Then, before drilling in spring, the land is worked down: the amount of working necessary depending upon the condition of the soil and whether winter frosts have broken it down or not. When barley is to follow a cereal there is time for a good deal of stubble cleaning in autumn and early winter before the final ploughing. On heavy land this final ploughing should be done before the new year if possible. Sometimes roots, folded late, delay the final ploughing too long, with the result that the *winter mould* is lost, and a faulty tilth is obtained. This adversely affects the barley, which, being a shallow rooted and quickly growing crop, needs a better tilth than any other cereal.

Varieties.

The work of the agricultural botanist has, during the past 30 years resulted in the older varieties being almost entirely replaced by two kinds, which are recommended for normal conditions: Plumage-Archer (bred by Dr. Beaven) is a two-row barley with erect, rather dense broad ears and a very short neck. It gives excellent yields on good soils and the grain which is large, plump and regular is of very high malting quality. Spratt-Archer (bred by Dr. Hunter) is a two-row barley with drooping, rather lax, narrow ears. It tillers well and stands well, giving very good yields of excellent malting quality. It is possible that Plumage-Archer succeeds best on heavier soil and Spratt-Archer on lighter land.

Both the above varieties are not infrequently sown in the autumn in south-east England and they will survive all but really severe winters.

Earl, a selection from Spratt-Archer, ripens earlier, but in other respects it is similar to that variety. Pioneer (2 rowed) and Prefect (6 rowed) bred by Dr. G. D. H. Bell are winter barleys with sufficient winter-hardiness to withstand quite severe winters. They both give good quality grain and are suited to soils of good or medium fertility.

When soil and climate require early ripening varieties the Danish kinds Kenia and Maja are suited for rich soils and Malster and Standwell for poorer soils. Kenia has very short straw and very good standing qualities. Scottish Bere, a six-rowed variety, is hardy, the grain is coarse but good for feeding; it is suitable for poor soils in northern districts. A similar variety is grown in Wales.

Manuring and Lime.

After a root or similar crop, generously treated, the land will frequently be in sufficiently good condition to grow a full crop of barley without any manure, depending, of course, on whether all or part of the root crop is carted off or fed off, on the land, or the tops ploughed in. After a white straw crop, or should it be considered for any other reason that manure is desirable, the following will usually give good results:

Heavy Land—

¾ cwt. sulphate of ammonia	Mixed together and applied before drilling.
3 cwt. super 30%	

Where there is fear of the barley becoming laid the superphosphate may be used alone or with a smaller proportion of sulphate of ammonia.

Light Land—

1½–2 cwt. superphosphate } Mixed together and
¾ cwt. muriate of potash.. } applied before drilling,
1 cwt. nitrate of soda or lime or "Nitro-Chalk" a few days after drilling or by end of March.

If clover is to be sown in the barley it is unwise to use much *nitrogenous* manure, but the use of phosphate and potassic manures (the latter especially on light land) for the barley, increases the prospect of a "plant" of clover and renders further dressings to the clover unnecessary.

Lime.

As previously noted, barley is very sensitive to soil acidity and a serious reduction in crop results from attempts to grow it on soil lacking in lime. If there be reason to suspect shortage of lime the soil should be tested as described under "Liming," page 154, and an appropriate quantity applied if possible 18 months before the barley is grown. If this has not been done, the barley will probably benefit greatly from lime applied before the land is worked down, previous to drilling. On very acid soil barley may fail completely.

At Tunstall plots were laid down on acid soil in 1932, with different quantities of ground chalk, some plots being left untreated. In 1936 and again in 1939 barley was grown upon these plots. The yields were as follows:—

	1936	1939
Unchalked plots	No crop.	No crop.
3 tons of ground chalk per acre cwt. per acre of grain	18·3	26·6

Seed Disinfection.—See page 152.

Sowing the Seed.

Most of the barley sown in Great Britain is drilled, but a little is broadcast in districts where drills are not available. The usual quantity of seed is 2½ to 3 bushels per acre. Before drilling, the ploughed land is worked down by means of harrows and other implements; these also follow the drill to cover up the seed. The average date of drilling varies according to district. In southern and south-eastern districts February is a favourite month if soil and weather permit, March is perhaps the most usual month, but much barley is drilled in April and often in early May.

Treatment During Growth.

Rolling is usually carried out when the land is dry enough; to consolidate the soil around the roots. Where the rows are sufficiently straight and weather conditions permit, the crop may be horse-hoed when it is 3 in. or so high. Harrowing is also carried out to kill seedling weeds and also to cover clover and grass seeds which may be sown in barley as a cover crop. If it is found impossible to kill most of the weeds by means of the harrow and horse-hoe, the crop may be sprayed. (See Tillage and Weeds, page 159).

Harvesting.

Barley should not be cut until it is dead ripe. If then there are no green weeds in it and no clover in the butts of the sheaves, it requires very little time in the field before it may be carted, given dry weather. Where green weeds or clover are present great care is necessary and time must be allowed or it will heat in the stack and this will spoil the grain. Barley is now usually cut by the binder or combine harvester but in former times it was frequently cut by the scythe and carted loose.

Covering Stacks.

As a rule there is a certain proportion of grain in the butt ends of sheaves of barley so that unless stacks are covered very soon after erection damage will occur. These odd ears in the butt soon grow when rain falls and this lets the wet into the stacks with disastrous results. For this reason the stack should be covered in some way as soon as it is at all possible—preferably the day its roof is finished. (See Stacking and Thatching, page 163.)

Threshing and Utilization.

In threshing barley which is intended for malting, the barley awns should not be broken off too short and the revolving drum should not be set too close or some of the grain may be broken. A considerable proportion of the highest quality barley grown in the British Isles is used in the manufacture of alcoholic beverages. For this purpose a grain with a high percentage of starch and a low percentage of protein is desirable. Barley is used for human food in the form of Pearl Barley, which has the husk removed and Barley Kernels, i.e., pearl barley which has been flaked. This latter is used for making milk puddings instead of rice—a purpose for which it is admirably suited. In 1943, owing to war conditions, a proportion of barley flour was added to the wheat flour in general use for bread-making. Barley meal is excellent for stock feeding; mainly as a source of carbohydrates. A barley which is too high in protein for the maltster is admirable for this purpose. In normal times it is extensively used for pig feeding but it may also be used for other animals, in all cases in mixture with foods containing more protein. Barley has a starch equivalent of 71, and a protein equivalent of 6·2.

Barley straw is not so good a food for cattle as is oat straw but if used in the long state so that the animals can pick it over and reject the unpalatable portions, it is quite useful. The part that the animals will not eat is used for litter.

Quality.

For malting purposes, as previously mentioned,

Above: PULLING FLAX. *Below:* CUTTING LUCERNE

Farmer & Stock-breeder Photographs.

Above: WEIGHING ROOTS AND TOPS OF MANGOLDS ON TRIAL PLOTS
Farmer & Stock-breeder Photograph.

Below: LAMBS FOLDED ON SWEET YELLOW LUPINS
Farmer & Stock-breeder Photograph. Courtesy: A. W. Oldershaw M.B.E.

a barley with a low protein content is required. It should also be dry and hard, cutting floury and free from all mouldiness. The grains should be uniform in size, well matured and plump, with finely wrinkled skins and of a nice straw colour. For feeding purposes barley should be well harvested and free from mouldiness, also with skin not too thick.

Yield.

An average yield is 36 bushels, but very wide variations occur. In unfavourable circumstances low yields may be obtained, whilst in certain cases yields of 80 bushels per acre are on record.

The heaviest yields known to the writer have been obtained after good farming either (*a*) on medium to heavy loams containing a sufficient supply of lime, in rather dry seasons, or (*b*) on lighter loams containing a sufficient supply of lime in seasons of average summer rainfall. A fair amount of frost in winter, followed by a good drilling season, undoubtedly has a very beneficial influence on yields of barley.

Rye.

Rye for grain has in the past, received little attention from the people of this country in times of peace. During wars, however, its great value has been recognized and its cultivation encouraged by the Government. It occupies a special place amongst cereals, owing to its ability to grow reasonably good crops on very poor, light and acid land. It is usually wiser to crop good land with other cereals.

Place in Rotation.

Rye is frequently grown after a leguminous crop such as lupins, tares, or peas. It may also be grown after a green crop folded on the land during the summer or made into hay or silage. This makes it possible to drill the rye at the end of September, which is undoubtedly the best time when grown for grain.

Rye is often grown for folding by sheep. In this case it may be drilled even earlier and is grown after almost any crop which happens to leave the land unoccupied in August or early September.

Preparing the Land.

As a rule the land is simply ploughed, worked down and then drilled. Sometimes, however, after a crop folded or removed in June or July, a good deal of cleaning may be possible before drilling. Thus a field of oats and tares, grown for silage, cleared in July, would be ploughed at once and a thorough cleaning given in August and early September. It would be drilled with rye in late September.

3 cwt. S of A per acre — *No Manure* — *3 cwt. "Nitro-Chalk" per acre*

Showing the effect of nitrogenous manures upon Rye. Each sheaf is the produce of 1 square yard.

(1) Received 3 cwt. Sulphate of Ammonia per acre.
(2) " No Manure.
(3) " 3 cwt. "Nitro-Chalk" "

Varieties.

Common English rye is usually grown. Mr. G. Lynn Shaw, who is associated with a well-known firm manufacturing a biscuit from rye, has made various selections, including a strain intended for spring sowing.

King II, introduced from Sweden, is short in the straw and appears to be promising.

Manuring and Lime.

Very little experimental work on manuring rye has been conducted in this country. On well-farmed land sufficient phosphates and potash for the requirements of rye will have been applied to previous crops; but nitrogenous manure as a top dressing in spring will be needed if, as is frequently the case, the land is naturally poor and light.

At Tunstall Experimental Station, on a light

Rye.—An ear, affected by the fungus disease " Ergot."

" blow-away " sand, the following crops of rye were obtained over an average of five years:—

Manuring.	*Yield of grain per acre* in stones.
No manure	57½
1½ cwt. Nitrate of lime or " Nitro-Chalk "	106½
3 cwt. Nitrate of lime or " Nitro-Chalk "	145

At the prices then prevailing, the cost of the heavier dressing of manure was 33/– per acre, and the value of the increased grain 153/–.

As previously mentioned, rye will grow well on soils deficient in lime, but a soil may be too acid even for rye. A mild degree of acidity appears to do the rye little if any harm.

Sowing the Seed.

On poor light soil rye intended for grain should, if at all possible, be drilled before the end of September. On better soil, later drilling will answer, especially if a mild winter follows. As previously mentioned, a variety for early spring sowing is being developed. About 2 to 2½ bushels of seed are usually drilled. When intended for sheep folding, rye may be drilled in August or September, and if the land is fairly good a valuable fold may be available for ewes and lambs in March and April.

After the land has been folded, there is plenty of time to get in a root crop.

Treatment during Growth.—Nitrogenous manure will often be applied in two dressings, the first during March and the second during April. If possible the rye should be horse-hoed.

Harvesting.

Rye comes out into ear very early, but is slow in ripening and should be allowed to get quite ripe before cutting or difficulty may be experienced in completely getting all the grain out at threshing time. It is cut with the binder, shocked and harvested, thatched and threshed in the same way as wheat.

Utilization.

In northern Europe much rye grain is used for bread; in fact, for bread-making rye is undoubtedly second only to wheat. Of late, much rye has been prepared for human food in this country by being made into a crisp biscuit. The grain of rye may be used for stock food, but care must be taken to feed only a small quantity daily in admixture with other foods, as it is rather heating. It gives good results when mixed with barley, maize or peas, but it is safest not to put more than 10 per cent in the mixture for pigs or death may follow.

On Cambridge University Farm 2 lb. of crushed rye and 10 lb. of oats and bran, making a total of 12 lb. daily, was fed to the working horses, but the horses of course received also a ration of hay, so that the rye only represented a small proportion of their total food. Rye grows a very large bulk of straw, often 40 to 50 cwt. per acre, certainly more than any other cereal. This straw is very little use for feed, but it is useful for general farm purposes—litter, covering up clamps of roots and for thatch. For this last purpose its great length renders it valuable, although many thatchers prefer wheat straw. It is also used for commercial purposes, such as packing pottery.

Quality and Yield.

Quality.

A well-harvested sample of rye is usually

regarded as of " good " quality. Some hold the opinion that the rye grown in certain districts contains more protein and hence is more valuable than that from other districts. It is most important that rye be free from " ergot," which is the most common fungus attacking rye. (See later.)

Yield.

In the past rye has often been grown on the poorest soils and has naturally given low yields; when, however, on such soils it is generously manured, heavy yields may be obtained.

At Tunstall Experimental Station, on poor light land, yields of 48 bushels per acre and upwards have been obtained on a number of occasions.

INSECT AND FUNGOUS PESTS.

Insects do little harm to rye. The most serious fungous pest is *ergot*. This disease shows itself in the ear at harvest time, when a purple body somewhat like a curved date stone is seen projecting from the ear. These bodies are threshed out with the grain and are poisonous. They must be removed, either by sifting or flotation in a solution of salt before the grain can be used for food. The disease is more prevalent in northern districts, as cold and rain at flowering time prolong the period in which infection can take place. The disease may be contracted:—

(1) From seed containing ergot;

(2) From soils into which ergots have fallen from a previously infected crop;

(3) From ergotized grasses in the immediate neighbourhood.

Hence use good seed, and do not grow crops liable to it, in succession.

This disease also occurs in wheat and barley.

CORN CROPS—*continued.*

In this concluding section on corn crops, mixtures including Dredge Corn and Mashlum are first described, and there follow sections on Peas and Beans respectively.

Mixtures of Corn.

Dredge Corn.

In certain districts, especially in Cornwall, mixtures of oats and barley are grown, under the name of Dredge corn. These mixtures, which are grown for stock feeding purposes probably owe their origin to the fact that it is often possible to grow a greater weight per acre of a mixture than of either grain separately.

Very often, too, there are patches of acid soil in fields and on these patches barley will fail; whereas oats may succeed. Again in some seasons frit-fly may spoil the oats, or gout-fly the barley; but it is unlikely that both these pests will attack the crop in one year. We thus see that dredge corn is grown where the conditions are somewhat hazardous for either crop separately. A common mixture is 1½ bushels each per acre of white oats, black oats and barley. The crop may be grown instead of either oats or barley in the rotation. It should be manured fairly generously. On land not in very good condition 1 cwt. of sulphate of ammonia and 3 cwt. super, mixed together and applied before working the land down in spring, would be a suitable dressing. If the land is poor in lime, "Nitro-Chalk," nitrate of soda, or nitrate of lime should be used (as a top dressing) instead of sulphate of ammonia.

Mashlum.

Mashlum consists of a mixture of one or more cereals (usually oats) with either beans or peas or both. Mixtures of spring beans and oats have been quite frequently grown in the past in Scotland on broken up grass land. Probably under such conditions the mixed crop is less hazardous than either crop grown separately. If the oats fail owing to wireworm attack, the beans may succeed. The beans may be spoiled by black aphis, but then the oats may grow a good crop. Spring beans drilled at the same time as oats do not always ripen by the time the oats are ready to cut. Hence it is quite common in Scotland to put the beans in a fortnight earlier than the oats. This entails two separate sowing or drillings. This plan would not be likely to succeed in those districts of England where oats are subject to frit-fly since late sown oats usually fall a victim to that pest.

During the war years a number of farmers in England drilled mixtures of beans and oats, partly with a view to providing stock feed containing a fair proportion of protein. With the same idea in view, mixtures of oats and peas or oats, peas and beans, were grown on a number of farms; it being hoped to obtain a home-grown food containing peas in a crop which could (unlike peas alone) be cut with the binder.

A fair degree of success was obtained from these crops, as there is no doubt that such mixtures are relatively safe to grow on broken-up grass land, provided they can be drilled early in spring, and there is sufficient lime in the soil for beans and peas. *Beans and Peas* (blendings), see "Peas," below.

Peas.

Climate and Soil.

Peas may be grown on a farm as grain for stock-feeding, as grain for human food, or they may be gathered green as a vegetable for human food. Different varieties are grown for these different purposes.

The drier parts of England are best suited for harvesting the grain, but when the peas are gathered as a vegetable, a relatively dry climate is not so important. Light loams containing a sufficient supply of lime are the soils best suited for peas, but the hardy kinds for cattle-feeding will thrive on heavier soils provided they are well drained. If the soil is not well drained peas will go yellow in a wet time and the crop may be a complete failure. Poverty of the soil in lime is as disastrous to the pea crop as is bad drainage.

Preparing the Land.

Where the land is fairly clean one ploughing is usually sufficient. On heavy land this should be given before Christmas in order to secure a *winter tilth.* On broken-up grassland a disc harrow is of great assistance in working up a suitable tilth and consolidating the turf before drilling.

Place in Rotation.

In ordinary arable farming peas take their place after barley or oats in the area devoted to leguminous crops and it is best not to grow them on the same land oftener than once in eight years. Where delicate and valuable varieties of peas are grown, they sometimes follow root crops as the land is then cleaner, and there is less trouble with weeds. During times of war peas have been found to be very suitable as a first crop to grow after grass provided the soil contains sufficient lime. Even on stiff clay land they have succeeded remarkably well.

Varieties.

Cattle Feeding Peas

Are, generally speaking, more hardy than other varieties. Amongst them may be mentioned:—

Norfolk dun.—An early ripening kind, with straw of medium length. It is widely grown in the eastern counties. Owing to the fact that this variety ripens early, the land can often be cleared and ploughed before general

harvest begins, and this is a great advantage.

Partridge or *Maple* peas are long strawed and rather late in ripening. The grain is mottled brown and yellow. In moist seasons and on good land this variety may grow too much straw and there may then be very little corn.

Black-eyed Susan.—The grain is dun-coloured with black eyes. The straw is fairly long. This variety ripens in mid-season and in the eastern counties is regarded as a good cropper.

Blue Peas.

For harvesting as grain for human consumption. Of these varieties Harrison's Glory, a marrow-fat pea, is perhaps the best known kind. The grain is fairly large and the straw of fair length, the flowers—as with other blue peas—being white. Harrison's Glory is a good cropper and moderately hardy.

Lincolnshire small blue pea, a long strawed variety is suited to less fertile soil. The grain is small, but good yields are obtained per acre. This variety is more hardy than Harrison's Glory.

Prussian blue peas are similar to, if not identical with, Lincolnshire blue peas.

Garden peas suitable for picking green are grown on farms to a considerable extent. They are less hardy than Harrison's Glory or the small blue peas. The number of varieties is very large.

Manuring and Lime.

Peas, like other leguminous crops, are able to assimilate the free nitrogen of the air, and for that reason do not as a rule need any nitrogenous manure. There may, however, be exceptions to this rule in the case of the more delicate garden varieties. As a general rule, farmyard manure is not needed for peas grown in the field. In the case of short strawed garden varieties such a dressing may be an advantage.

The following suggestions are based upon the limited amount of experimental work done on manuring peas in this country.

Heavy Land:—

4 cwt. 30 per cent superphosphate applied before drilling; or 5 cwt. basic slag (high quality) applied a few weeks before drilling. A little potash may be used if thought desirable.

Light Land:—

1 to 2 cwt. super .. 1 cwt. muriate of potash	Mixed together and sown on the same day as mixed; and before drilling the peas.

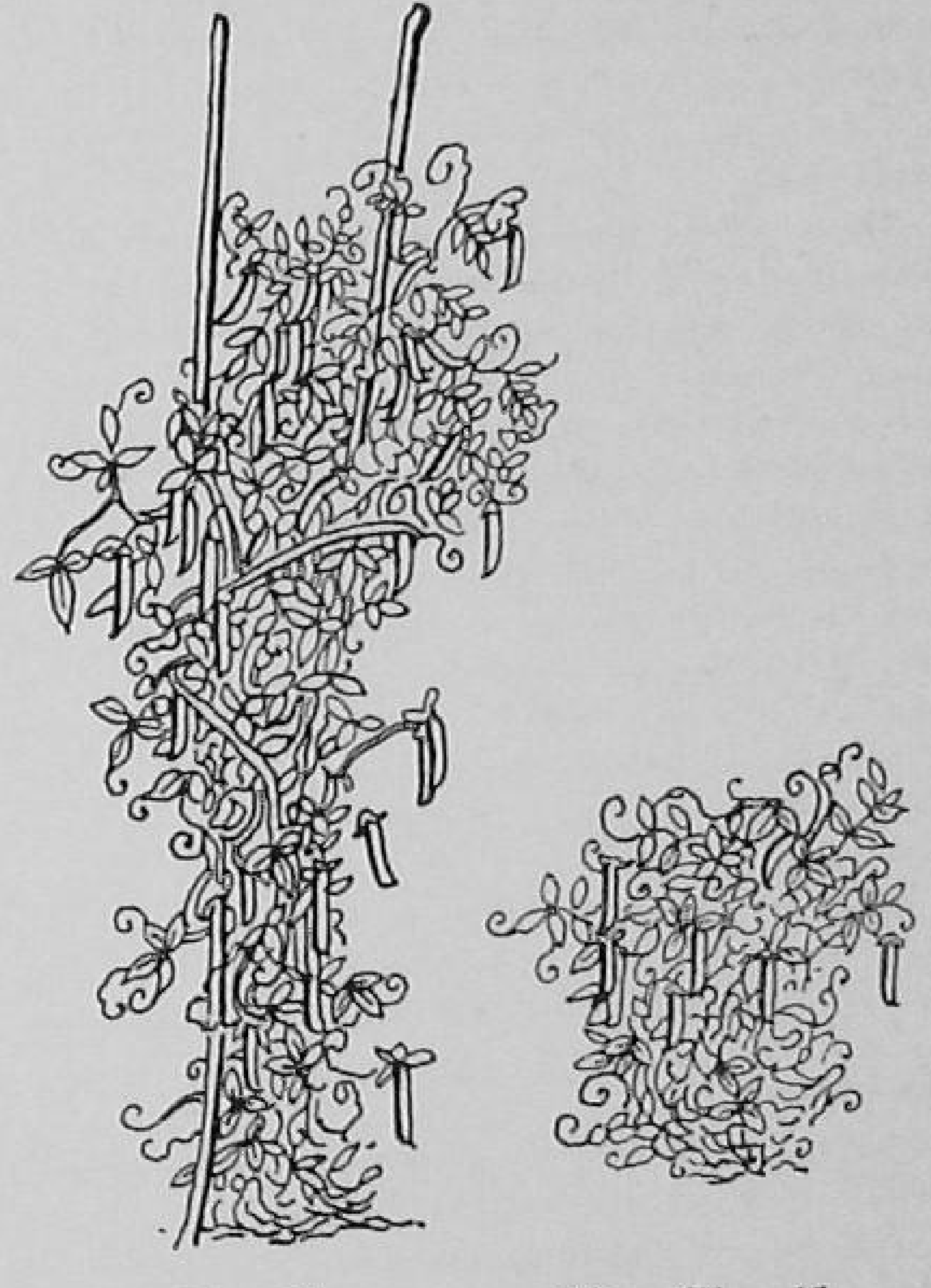
Cases have occurred where combine-drilling of artificials has resulted in complete failure of the crop, hence this should not be attempted.

Lime in some form must be present. When deficient it must be applied as long as possible before drilling the peas, otherwise there is serious risk of partial or complete failure of crop; at least 18 months before drilling the peas is best to give it time to act.

In early districts and when the state of the land permits, stock-feeding peas are often drilled in January or February.

Sowing the Seed.

Blue and garden peas, being more delicate, may not be drilled until March or even April; but this depends upon the state of the land. Those anxious to secure early garden peas for picking may take considerable risks in order to catch the early market—in fact, in relatively mild districts and on light loams, peas for picking green are sometimes drilled in November. The seed of delicate varieties drilled early on heavy



Peas must have enough lime in the soil.

Peas on an acid soil. Lime in the form of 5 tons per acre of soft lump chalk was applied 14 years before the crop was grown. The unchalked part of the field gave practically no crop.

land may very often rot in the ground. When peas are drilled early it is wise to disinfect the seed with an organic mercury seed dressing. This renders the seed less likely to rot in the ground and helps germination.

The seed is drilled at the rate of 2½ to 4 or even 5 bushels per acre, the rate depending upon the district, the soil, the date of drilling, the variety and the germination. Where the seed of blue peas is hand-picked less is required per acre.

The rows may be 9 in. to 11 in. apart, and in the case of garden peas grown in the field, 18 in. or even 2 feet apart. Wider distances permit of easier horse-hoeing. Mr. S. O. Ratcliffe of

Maldon, Essex, drills double rows of peas 4 in. apart and 20 in. apart from double row to double row. When the peas are 6 in. high, he drills cabbages or kale or another Brassica midway between the double rows. Apparently the peas shade the cabbage seedlings, which make good growth after the peas are removed.

Treatment during Growth.

In order to destroy weeds, harrowing may be carried out soon after the young shoots are above ground. Horse-hoeing or hoop-hoeing, weather permitting, is done when the shoots are 2 in. to 3 in. high, and this is followed by hand-hoeing where labour permits. Neglected fields of peas tend to become very full of weeds.

Spraying with D.N.B.P. has given good results.

Harvesting.

The method adopted depends to some extent upon the value of the variety being grown, since the most valuable varieties are worthy of most care. In the past, when labour was plentiful, the common way of harvesting peas was by hand, using what is known as a pea-hook, i.e., a metal blade, slightly curved, fastened to a shaft. This was used to cut off the pea haulm very near the root, and then the cut peas were rolled into small heaps. Some growers use a scythe to cut peas instead of a pea hook. With valuable varieties it is quite worth while to have a large gang of women and children pulling the plants off at the roots.

Where labour is scarce, some mechanical means of harvesting is used—say, a grass-mower, or a side-delivery reaper fitted with pea lifters to lift the peas off the ground in front of the knives.

A pea harvesting attachment may be attached to the mower—this causes the peas to slide out of the way of the machine when it comes round next time and so renders their removal by hand unnecessary. A horse-rake taking half its width or a hay toppler used the same way, may also be used for taking up peas; but these mechanical means sometimes lead to loss by shelling.

Recently, the Leverton pea harvester has been found satisfactory, whilst the Hume-Love Tractor Rower has given good results in trials.

After the peas have been out a short time, and are dry on the top, they must be turned, the only way to prevent the peas from being spoilt in a wet time is to turn frequently. In 1941, in a wet harvest, a field of blue peas was turned 13 times, but the crop was saved from ruin and made a good sample which sold at a high price. If the grain is not very dry when carted the peas should be put in a narrow stack in a draughty place. It will be found that they will very much improve in this way. A ventilation shaft arranged in the stack by means of hurdles is very useful in drying the grain.

The day that the stack is erected it should be covered by an abundance of loose straw, or otherwise protected. Peas are so open in character that rain will go straight into them. Whatever method of covering the stack is to be finally adopted, plenty of loose straw on the roof will greatly protect the peas. (See Thatching of Stacks, page 164.)

Where a Dutch barn is available peas will naturally be placed under it in preference to most other corn. If the pea-stack cannot be protected in any other way it must be covered by a stack cloth until it can be thatched. Where the peas are valuable it is quite worth while roughly to thatch the sides as well as the roof.

Peas do not, as a rule, suffer very severely from attack by fungus and they have not been known to be attacked by the stem-rot fungus (*Sclerotina*) which is such a serious pest on beans and clover.

Blendings (Beans and peas mixed) are sometimes grown in order to secure a crop containing peas which can be harvested by the binder.

Spring beans, 2 bushels per acre, mixed with ¾ bushel of maple peas, has been found suitable, the two plants ripening at about the same time and giving a crop which stands up fairly well. Such a mixture is very suitable for growing as a first crop on second class heavy land grass. When winter beans fail in spring they may very fittingly be filled up by dun peas.

Peas and oats in mixture have occasionally been grown (especially during the second World War) with the idea of providing cattle food fairly rich in protein. On medium to light loam such a mixture is suitable as a first crop on broken-up grass and probably safer than either crop separately. (See Mixtures of Corn, page 180.)

Threshing and Utilization.

The threshing of peas is a simple matter. As the crop is untied it is simply fed into the " drum " with a hand-fork. In the case of blue peas the grain is reserved for human consumption, unless it has been so much damaged in harvest as to be unfit for that purpose.

Stock-feeding peas form a valuable source of home-grown protein, and in admixture with cereals are used to make a balanced ration for all classes of stock. They are especially valuable for pigs; an old-fashioned and very reliable mixture for these animals being one-third pea meal, one-third maize meal, and one-third barley meal.

Peas contain 18 per cent of protein equivalent, compared with 20 per cent in the case of beans, and their starch equivalent is 69.

Where table varieties of peas are grown the pods are gathered green. Pea straw, if well harvested, is valuable as fodder for cattle; its protein content (3·8 per cent) being double that of any other straw commonly grown.

If badly harvested, it is used for litter, in which case it makes farmyard manure richer

in nitrogen than do the cereal straws.

Average Yield.—This varies widely according to season and variety. In good seasons and on good land 40 and even 50 bushels per acre may be obtained whilst in bad years the yield may be small. As a rule stock-feeding peas are hardier and yield rather better than blue peas.

Insect Pests.

The most serious insect pests are the green aphis, the pea weevil and the pea moth and maggot. In some years the aphis completely ruins the crop so that it is not worth harvesting for grain. In this case it has been made into silage with great success. An aphis-infested field of peas may be folded by sheep. Peas are singularly immune from injury due to wireworm attack and partly for this reason succeed well as a first crop on broken-up grass.

NOTE:

The Home-Grown Threshed Peas Committee, 45 Bedford Square, London, W.C.1, publish several valuable leaflets on pea-growing with details regarding varieties, cultivations, insect pests and the Four Poles System of Harvesting.

It may be mentioned that the pea weevil may be controlled by dusting with "Flea Beetle" dust or D.D.T., and the Aphis by nicotine fumigation or by spraying with D.D.T. emulsion. The latter also controls the pea moth maggot.

Weeds.

Many kinds of weeds in peas may be killed by spraying with preparations based on D.N.B.P. Most kinds of spraying may be done efficiently by specialist contractors, who naturally have more experience in the work and are consequently less likely to make the mistakes which lead to loss of crop. There is some risk in spraying peas.

In the *Four Poles* system of harvesting peas, strongly recommended by the above Committee, the crop is piled on the "four poles" when all the sap has dried out of the haulm. The whole is kept off the ground and protected from the weather, with the result that in many seasons waste is greatly reduced. Battens of straw, fixed around the top of each "cock" can afford almost complete protection from the weather.

FIELD BEANS.

Soil and Climate.

In certain parts of England, especially in the eastern and midland counties, field beans are a very important crop. They are associated with the heavy soils which occur in these counties.

Although beans will thrive upon a considerable variety of soils, they are most suited to heavy loams containing an abundance of lime. Good crops may be grown on very stiff clays, provided they are well drained and, in seasons of ample spring and summer rainfall, good crops may also be obtained on comparatively light soils provided there is sufficient lime present. Winter beans are largely grown in the southern half of England, but in the north of England and in Scotland spring beans are more commonly grown because the winter there is often too severe for autumn sown beans.

Place in Rotation.

In the four-course rotation beans follow barley or oats, occupying part of the leguminous shift, the remainder of that shift growing clover or peas. Thus if we had 12 fields, numbered 1 to 12, beans might be grown on field No. 4, peas on No. 8, and clover on No. 12. Then next time the rotation goes round, field No. 4 would grow clover, No. 8 beans and No. 12 peas. In this way any one of these three crops would actually only occupy the same ground once in twelve years. This is a considerable advantage since a long interval between these crops renders them less likely to suffer from disease.

During the great wars, beans have been found very suitable as a first crop after grass on second class heavy land provided enough phosphates were present.

Preparing the Land.

Autumn sown, or as they are commonly called *winter beans*, must be put in, if possible, during October. This leaves only a short interval after the previous crop—usually barley, oats, or wheat. After an early harvest, especially in southern and eastern England, it quite frequently happens, however, that a good deal of stubble cleaning can be done. This work begins immediately the stubbles are cleared. The land may be tractor- or horse-cultivated. This breaks the surface, causes many weed seeds to germinate (if there is enough moisture) and if favourable weather follows even many perennial weeds may be killed. The seedling weeds are killed by burying them when the land is ploughed.

Farmyard manure (which is very good for beans) is carted out if it can possibly be spared; a suitable application being 10 tons per acre. After spreading, this is ploughed in as soon as possible. The amount of stubble cleaning which can be done depends upon the weather—and upon the date of clearing the previous crop off the land. After a late harvest, stubble cleaning, especially in later districts, is often impossible. Farmyard manure is then carted on to the stubbles and ploughed in.

When it is intended to drill spring beans, there is more time, and ploughing even on heavy land may be left for completion until December.

Varieties.

Various attempts have been made to improve ordinary beans by selection and otherwise, but it

is by no means certain that these new selections are superior to the originals. The writer has tested these selections a number of times with inconclusive results.

Of spring beans there are several distinct kinds, but they are none of them winter hardy, and they do not tiller so well as winter beans.

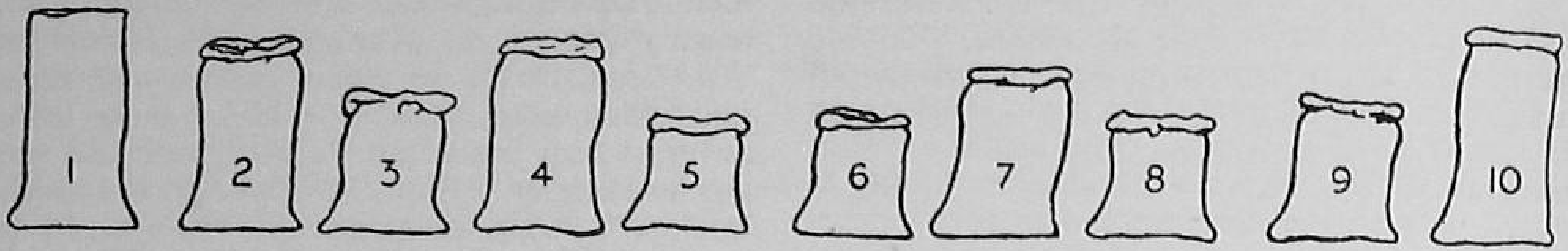
Ordinary English spring beans are perhaps the most extensively grown.

The Scottish horse-bean is a vigorous growing kind. The English tick bean is commonly grown in Lincolnshire—the grain is small and round.

Mazagan beans have a larger and flat grain.

addition, the larger the crop obtained, the more highly-nitrogenous food there is for the live stock on the farm and this means more and richer farmyard manure. The net result is that by the purchase of mineral manures only; the farmer greatly enriches his holding in nitrogen obtained from the air.

Beans, like all other leguminous crops except lupins, will not thrive on acid soils (i.e. those deficient in lime). Hence, before attempting to grow them, the soil should be tested for lime, unless the farmer knows by previous experience that beans will succeed. Failures of crop,



Winter Beans from Saxmundham Heavy Land Experimental Station.

Each plot has received the same manure for 40 years, but has been cropped in rotation:—Wheat, mangolds, barley and leguminous crop (beans, peas or clover).

Plot (1) 6 tons Farmyard Manure.
,, (2) 4 cwt. Bone Meal.
,, (3) 2 cwt. Nitrate of Soda.
,, (4) 2 cwt. 30 per cent Superphosphate.
Plot (5) 1 cwt. Muriate of Potash
,, (6) No Manure.
,, (7) {2 cwt. Super. 1 cwt. Muriate of Potash.}
Plot (8) {2 cwt. Nitrate of Soda. 1 cwt. Muriate of Potash.}
,, (9) {2 cwt. Nitrate of Soda. 2 cwt. Super.}
Plot (10) {2 cwt. Nitrate of Soda. 2 cwt. Super. 1 cwt. Muriate of Potash}

Note the beneficial effects of Farmyard Manure, of Phosphates and of Phosphates and Potash together.

Manuring and Lime.

As a result of experimental work conducted over a long period of years at Saxmundham, Rothamsted, Cockle Park, and in Scotland, the following scheme of manuring is suggested: For heavy and medium soil—

10 tons per acre of farmyard manure and
3 to 4 cwt. 30 per cent super or
4 to 5 cwt. high quality basic slag . . . . } Applied before drilling the seed.

If farmyard manure is not available, then—

4 to 5 cwt. 30 per cent super
or
5 cwt. high quality basic slag
and
½ to 1 cwt. muriate of potash. } Mixed together and applied immediately after mixing and before drilling the seed.

Beans, like all other leguminous crops, can obtain nitrogen from the air. It is probably wasteful, if not actually harmful, to apply nitrogenous manures such as nitrate of soda or sulphate of ammonia to them.

It is a very wise proceeding to apply phosphates (and potash where necessary) to leguminous crops, since any increased growth obtained enriches the land with more root residue. In

especially when these failures occur in patches in a field, often indicate lack of lime.

Sowing the Seed.

In the case of winter beans the ideal time for drilling is probably the first three weeks of October, but later drilling—even up to the end of November—often proves a success especially when a mild winter follows.

In a mild winter drilling too early causes the beans to get too forward and then they are more apt to be injured by frost. After ploughing, the land is worked down and drilled in the ordinary way. The rows of beans may be 18 in. to 2 feet apart, but sometimes they are as narrow as 10 in., especially with spring beans. The wider distances enable horse-hoeing to be performed more efficiently. In the case of winter beans 2½ bushels of seed is a usual quantity per acre—spring beans require about 3 bushels. Winter bean seed is quite commonly ploughed in—a little one-row drill is fixed behind the plough and put into gear every second or third furrow. Only a shallow furrow is used, say 4 in. deep. The advantage of this on very sticky land is that once the ploughing is finished the crop is safe until spring. If the land is ploughed in the ordinary way a very wet autumn may make the

drilling difficult or even impossible on a sticky soil.

After drilling, care must be taken to cover the seed efficiently by harrowing, but it is not an advantage to reduce the surface of the soil to a fine tilth since a number of clods protect the small beans from wind frost. In the case of autumn sown crops in general too fine a tilth may mean that the surface of the soil is panned down by winter rains. Where beans are ploughed in it may be unnecessary to harrow until spring time.

Treatment During Growth.

As soon as the land is dry enough, say about mid-March, the crop may be rolled and then harrowed. The two operations break down clods and solidify the soil around the roots. Harrowing kills many seedling weeds. The beans are then horse-hoed. It is a very good plan to fit A-shaped hoes to the corn horse-hoe for the first horse-hoeing to break the winter crust. These A-hoes may be 12 in. wide if the rows of beans are 20 in. apart, and three rows may be done at a time quite conveniently. In subsequent horse-hoeings L-shaped hoes should be used to get as near to the rows of beans as possible. In some districts a drill-grubber, of the type used for cultivating one row of potatoes at a time, is used for beans. Where possible hand-hoeing should be performed and all docks removed.

Harvesting.

Beans should be cut when the hilum, or point of attachment of the grain to the pod, goes black. If left to become dead ripe, beans often shell badly and a large quantity of grain may be left upon the ground—this is especially so in a dry season. As a rule beans do not suffer very seriously in the field, even if the weather is not very good, but after a heavy rain the shocks should be moved, so that the wind may penetrate better. They require plenty of time in the field, to permit all sap to go out of the straw. If they are not in very good condition when carted, they should be put into narrow stacks; the wind will then draw through them and their condition will be greatly improved in the course of a few months.

As bean straw is very open in character, heavy rain falling before the stack has been protected in any way may go straight down and cause very serious damage. Hence it is wise to top up the stack with loose wheat straw as indicated in the section "Thatching and Covering of Stacks."

Threshing and Utilization.

Threshing takes place in the same way as with other corn. The grain shares with peas the distinction of being the only corn commonly grown in Britain, which is rich in protein. Beans usually contain 19 per cent of digestible true protein and have a starch equivalent of 66.

FORAGE AND GRAZING CROPS

Our author indicates the importance of recent work on grassland management. The classification of grassland has been made into grades which range from first-rate rye grass pastures to the poorest of heaths and thorny derelict land. Methods of improvement are dealt with; among the subjects thus treated are manuring, ploughing up and re-seeding. The suitable climatic and soil conditions are mentioned and there are sections in this section on Preparation of the Land, Sowing and Mixtures of Seeds. The utilization of the crop is discussed under the headings of Grazing, Haymaking, Silage and Dried Grass. There follows an account of some of the different kinds of grasses grown. The Clovers, Lucerne, Sainfoin, and Tares finally receive treatment, and in each case such points as sowing, manuring and utilization of the crop are included.

GRASS AS A CROP.

Grass.

FROM a botanical point of view, Grasses are nearly allied to the cereal grains, and it is beyond the scope of this book to consider more than a few of the most important. " Grass " as a crop however, as grown in the British Isles consists of an intimate mixture of grasses and clovers and often includes quite a number of plants of other botanical families. The area of grassland in Great Britain even in times of war is very large. A considerable area of land is unsuited for anything else.

Much has been discovered during the past 40 years about the management of grassland owing to the work of Sir Wm. Somerville, Sir Thos. Middleton, Sir George Stapledon, Professor Hanley, Dr. Wm. Davies, Mr. J. R. Bond, and others too numerous to mention. Sir G. Stapledon, Dr. Davies, and their colleagues made a survey of the grassland of England and Wales, ending in 1940.

In 1938 we had in this country a larger proportion of grassland than ever before. Not only was the arable land going out of cultivation but the poorer grades of permanent grassland were deteriorating and adding to the acreage of rough grazings.

In 1939 we had in England and Wales:—

Permanent Grass	15,702,000 acres.
Rough and Hill Grazings ..	5,601,000 "
Arable Land including Temporary Leys	8,926,000 "

Types of Grass Land.

Sir G. Stapledon and Dr. Davies divided grassland into a number of different types, from first grade rye grass pasture to the poorest of heaths and thorn-covered derelict land. It appears that *first grade rye grass pasture*, in which perennial rye grass contributes 30 per cent or more to the sward, occupied about 251,000 acres, largely in the Welland Valley (on the borders of Leicestershire, Rutlandshire, and Northamptonshire) and in the eastern portion of the Romney Marshes in Kent. Wild white clover is always plentiful in this type and fescues, timothy and meadow grasses are often present. Second grade rye grass pasture in which perennial rye grass contributes 15 to 30 per cent, occupied about 912,000 acres. The grasses dogtail, fescues, foxtail, timothy and cocksfoot are present in appreciable amounts together with clovers. *Third grade* rye grass pasture, usually based upon *Agrostis* or bent grass and wild white clover, with perennial rye grass up to a maximum of 15 per cent of the herbage, occupied 4,317,000 acres. Meadow grass, foxtail, fescues, cocksfoot and other grasses make important contributions. The remainder of our very large area of grassland regarded as below the level of third grade, varies from *Agrostis*, and *Agrostis* with fescues pasture, of which we had a total of 9,580,000 acres, to the very poorest of rough and hill grazing.

Truly this presents a sorry picture of the crop " grass," for which our land and climate are supposed to be peculiarly suited.

Dr. William Davies says: " The preponderance of pastures of the agrostis group in lowland situations all over the country is of particular significance. Practically the whole of these could, with better treatment and improved utilization, be brought to the standard of average rye grass pastures. The potential output from grasslands of this country would then be very great."

Improvement.

Methods of improvement without ploughing.— The introduction of basic slag in the last decade of last century caused widespread interest in the improvement of grassland. It was found at Cockle Park Experimental Station in Northumberland, and elsewhere, by Sir Wm. Somerville, Sir Thos. Middleton, Prof. Gilchrist and many others that basic slag had a remarkable effect upon poor, heavy land pasture by promoting the growth of wild white clover. This improvement was greatest when a heavy dressing —10 cwt. per acre of high grade, high quality slag was applied at first, followed by further dressings every few years. The improvement caused by treatment of this kind can only be described as wonderful. An absolute carpet of wild white clover followed and the stock-carrying capacity of the land was greatly increased, especially when the land was well grazed. Very large quantities of basic slag have been used in this way since 1895. Great areas of land which had tumbled down to grass in the nineties of last century were immensely improved. The reason is that on such land there are often small plants of wild clover growing naturally in mixture with

the grass. The land is poor in phosphates and the application of basic slag causes the small plants to make greatly increased growth, often until they occupy most of the turf. The best results from basic slag are obtained on heavy soil in which there is a certain amount of vacant space in the herbage. This gives room for the wild white clover to spread.

Poverty of grassland in lime can be detected by the colorometric test described under "Liming," (page 154). As a rule grassland which is poor in lime has a "mat" of undecayed vegetable matter on the surface. When walking over it this can be detected by the spongy feeling underfoot. A knife cutting into the turf reveals one, two, or even three inches of matted material which is very difficult to wet through. Even after exceptionally heavy rain the writer has found the soil under such a mat, quite dry.

It is impossible to get good grazing under such conditions. A heavy dressing of some form of ground carbonate of lime (quick lime burns the grass) or chalk or lump chalk, or waste lime, will cause a great improvement in the course of years, but this improvement is slow. There is no doubt that the best way of dealing with such pastures is to plough them up and then apply lime and phosphates.

Manuring.

The following are suggestions for treatment where it is not proposed to plough up. In the improvement of grassland, manuring and management are equally important.

Pastures.—It is always a good plan to try out small scale experiments on the land in question before embarking on a large scheme of manuring.

Heavy land will usually respond to basic slag or super if well grazed and scarified so that the manures have a chance to be effective. The most successful method, as a rule, is to give a fairly large initial dose of 10 cwt. slag or 5 to 6 cwt. super, and then smaller doses of, say, about half as much at 3- or 4-year intervals.

Medium and Light Grassland.

If lacking in lime, apply some form of that substance—but preferably not quicklime which burns the grass to some extent.

In addition—

5 cwt. of basic slag and 1 cwt. Potash Salts (40%)	Will often give good results on medium loams applied in autumn.
On light grassland 2 cwt. 30% super and 2–3 cwt. Potash Salts (40%)	Mixed together and applied in February.

A similar dressing may be given every few years.

Nitrogenous manures, at the rate of 1 cwt. per acre at a time, may be applied on grazing land with advantage in order to get early or late bites and to generally increase productivity. Unless the land is kept well grazed, however, they tend to encourage the grass at the expense of the clover. They are less effective in those districts which are subject to severe droughts.

MANURING FOR HAY.

Heavy Land.

An initial dressing of 10 cwt. basic slag or 5 cwt. super. In the case of land to be seeded down this should be applied before sowing the seeds. After two years an annual dressing of:—

2 cwt. super.
1 cwt. sulphate of ammonia, or other nitrogenous manure.

This treatment resulted in excellent crops for 12 years on land laid down at Saxmundham Experimental Station in 1926.

Lighter Land for Mowing.

Initial dressing—

3 cwt. super.
2–3 cwt. Potash Salts (40%).

After two years an annual dressing of:—

3 cwt. 30% super.
1 cwt. Potash Salts (40%).
1 cwt. nitrate of soda, nitrate of lime or "Nitro-Chalk."

Surface Cultivation.

In spring ordinary grassland receives a good chain harrowing to level it down, distribute the droppings of animals, and distribute mole hills, etc.

Inferior grassland may often benefit by what Sir G. Stapledon calls a "fierce" harrowing. This given after phosphates and lime or both have been applied may break the surface and enable the running stems of the wild white clover to get hold and spread. Drastic treatment of this kind may also assist in causing the decay of a surface mat. Drastic trampling by stock in winter may have a similar effect. In the case of good heavy grassland, however, much harm may be done by heavy stocking with cattle in winter. The hoofs of the animals may so seriously poach the surface that growth is greatly reduced the following summer.

Relative Productivity of grass and arable land.—Years ago Sir Thomas Middleton estimated that to carry the meat produced on one million acres of average grassland, 40 ships of 5,000 tons each would be required. To carry the produce of a million acres of average wheat land, 200 vessels of similar tonnage would be wanted.

Ploughing.

Improvement by ploughing-up and re-seeding.—Of late, great stress has been laid upon this

method of improvement of grassland by Sir G. Stapledon and his colleagues, and by many others. Mr. J. R. Bond pointed out the possibility of direct re-seeding in Derbyshire soon after the war of 1914-18. "Take the plough round the farms," has become a slogan. The work at Cahn Hill Research Station, in Wales, has shown remarkable results with hill-grazing, whilst more recently a grassland research station has been established by the Ministry of Agriculture at Dodwell near Stratford-on-Avon. This is on extremely stiff Lias clay—typical of a large area of poor heavy land pasture in the midlands. There is no doubt that a very large area of poor grassland of many types would be better broken up, put through a course of tillage, suitably manured and limed (where necessary) and then re-seeded. "Whether in war or peace," says Dr. Wm. Davies, "it is the plough and the cultivator which can improve land most quickly and in the best manner." The plough and cultivator should be taken round the farm.

This is especially the case with second, third or fourth rate grassland. There are various reasons for this. On inferior benty and weedy grassland, manures such as slag sometimes cannot work satisfactorily because there is so much inferior herbage which cattle will not eat and through which wild white clover cannot grow. Again, a very large proportion of the herbage consists of inferior plants which are well established and which cannot be got rid of very easily without ploughing. Another reason is that if the land is ploughed and cultivated, the necessary mineral manures—phosphates and/or lime can be thoroughly mixed with the soil. The introduction of wild white clover seed, and other valuable pasture plants, during the present century, has also rendered it possible to obtain a good pasture in a very short space of time. Dr. G. H. Bates said: "It was an ancient belief which endured until recently, that it takes fifty years to make a pasture. We now know that under favourable circumstances it can be done in fifty days." To this the author would add that in the drier parts of England, such very favourable circumstances only occur occasionally and he personally would prefer to say 50 weeks, rather than 50 days, in such districts. Very inferior pasture, full of weeds, ploughed up, thoroughly cleaned, suitably manured, limed (if necessary) and put through a course of tillage, may give quite good arable crops for several years. If the land is then put down to a simple modern grass mixture containing wild white clover the resulting pasture may be incredibly superior to the original. This applies to many, perhaps to most types of land. Where, for various reasons, such as liability to flooding, unsuitability of climate or land for arable crops, it is difficult or impossible to put the land through a course of arable cropping, it may be re-seeded at once. Sometimes where there is much inferior surface vegetation this has been deeply buried by tractor ploughs taking a very deep and wide furrow, when very little of it may come up again. Where rocks abound, stump-jump ploughs may be used. Where there are many weeds and the land must be re-seeded after a shallow ploughing a cheap mixture of rye grass and clover may be used, intended to last only one or two years. This gives time for the surface vegetation to rot, and prepares the way for a more thorough seeding. Owing to the very diverse conditions which exist, it is impossible to say exactly what ought to be done in any particular case, but it is desirable for those contemplating such work to consult the local National Agricultural Advisory Service unless they have previous experience.

However, the general principles are to get rid of weeds either by tillage or by burying them in order to clear the ground for superior plants. These will not succeed, however, unless soil conditions are made suitable, proper drainage must be provided, and lime and phosphates must be added if either or both of these materials are lacking. Cases of inferior grass fields broken up and then re-seeded (either at once or after a few years of tillage) have been seen standing out, like oases in the desert, when compared with the grassland in adjoining fields.

Climate and Soil.

The western districts of Great Britain are better suited for grass than the eastern and southern because the rainfall is higher. Light soil in a dry climate is ill suited for grass—the productivity is very small and in dry summers hardly anything for weeks at a time. Such soils are better suited for herbage crops such as lucerne and sainfoin than for grass, especially in the eastern counties.

Preparation of the Land.

In most but not all cases grass seeds are sown in a cereal cover crop, either immediately after the grain is drilled or when it is 2 in. to 3 in. above ground. In the latter case the cereal may be horse-hoed, before the grass seed is sown, or the seed may be horse-hoed in. As with clover, it is important to get a solid seed bed, and a rib roll is excellent for the purpose. It is also important that there shall be a fine tilth.

If the land was poor in lime, a dressing should have been applied previously. On heavy soils a good dressing of basic slag before sowing the seeds is likely to increase the chances of getting a good "take."

Sowing.

The seed may be sown broadcast by hand or by the "fiddle"—a simple mechanical sower; or by a seed barrow, or it may be drilled. In dry districts the last plan is more likely to result in a good "take" of seeds.

The mixed grass and clovers make small growth the year of sowing, when sown in a corn

crop. When sown alone, as is sometimes done, especially when re-seeding grass in high lying districts, more growth is made in the first season, this depending largely upon the rainfall.

In the year after sowing the crop comes to full growth and may be either mown or grazed. If it is desired to make a good pasture the latter plan is probably to be preferred, but if merely temporary results are required mowing may give good returns.

Mixtures of Seeds.

Most of our best pastures consist largely of perennial rye grass and wild white clover and when sowing down a fresh pasture it is now considered unnecessary to sow many species of grass —simple mixtures being very good.

It is impossible in the space at our disposal to consider the very large variety of grass seed mixtures which might be suitable under the varying climatic and soil conditions of the British Isles. In this connection it may be mentioned that the Ministry of Agriculture in conjunction with the Seed Production Committee of the National Institute of Agricultural Botany has issued a series of suggested mixtures suited for general purposes. One of these—a typical mixture for three years or longer leys is:—

	lb. per acre.
Italian Rye grass	4
Perennial Rye grass	12
Commercial Cocksfoot	4
Certified Leafy Cocksfoot .. .. (S. 37, S. 26, or S. 143.)	4
Timothy	4
Late flowering Red Clover	3
English wild white clover (certified if available)	½
Certified S. 100 or certified New Zealand white clover	1

The writer has found in a long duration ley in the comparatively dry climate of Suffolk, that the inclusion of a few pounds of lucerne seed per acre in the mixture improves the hay crop from such leys, especially in dry years. Even on heavy land this has proved to be the case, and on light land it may make a great difference to the yield in most seasons. In fact, on really light land, in a dry year, ordinary grass and clover mixtures may produce very little after the first year. Kidney vetch is a desirable ingredient of light land grass mixtures. Those who propose to put down leys under conditions rather different from the average would be well advised to consult the local agricultural advisory service.

Grazing.

Good grazing is extremely important. The best results are obtained by mixed animals. Horses or sheep alone lead to selective grazing. They neglect the coarser patches. Horses especially by selecting one portion of the field in which to deposit their dung lead to very coarse patches.

It is probable that all pastures should be eaten down close to the ground once during the year, preferably in winter.

The methods adopted in making hay differ widely in different parts of the country largely owing to difference in climate and size of farms.

Haymaking.

To secure really high class hay the grass should be cut early. Reasonable quality with plenty of bulk is obtained when the majority of grasses are in flower shewing their stamens. Early grass is more difficult to make into hay, being more succulent. Tripods and "Four Poles" (see Peas) have been found very useful in making high quality hay.

Silage.

In districts of heavy rainfall where haymaking is difficult there can be little doubt that making silage from grass is a very desirable proceeding. When the grass is cut in a fairly young stage very high quality silage can be made providing the original grass is of high quality.

Dried Grass.

Grass cut in a young state, when it is rich in protein and then artificially dried has been found to provide a very highly nutritious stock feed approaching in some cases to a "concentrated food." It is not yet quite certain, however, whether this is an economic proceeding under normal conditions. Very heavy expenditure on equipment and fuel is necessary. Unless first class green material is used the "dried grass" may be little better than hay.

Species of Grasses.

Many species of grasses occur in our pastures. Forty years ago it was considered desirable to sow the seed of a considerable number of species mixed together when putting a field down to permanent pasture. It is now considered that only a few of the larger grasses are worth sowing. Of these commercial and also leafy strains are available, many of the latter coming from Aberystwyth Plant Breeding Station.

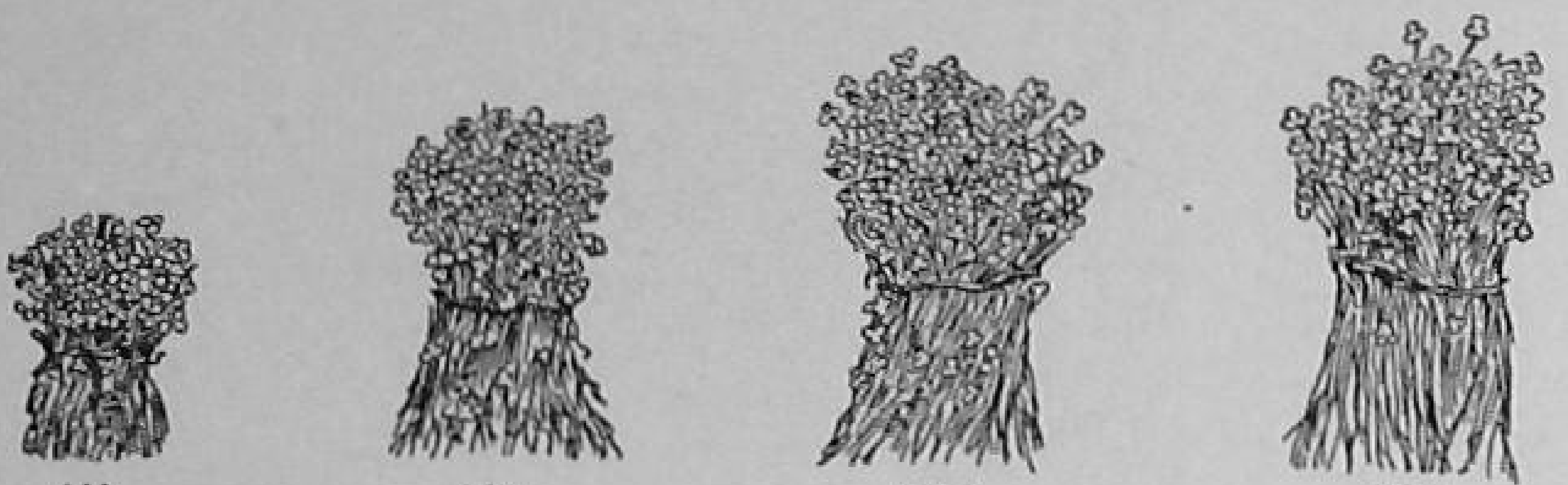
Italian rye grass is a large erect-growing grass which only lives a short time. As a pasture grass of short duration it is pre-eminent amongst British grasses. It starts growing very early in spring and hence is most valuable for giving an early bite. It is also very responsive to nitrogenous manure. In mixtures it does not produce as much hay as perennial rye grass, as its early habit smothers the other species.

Perennial rye grass.—The commercial strains of this give heavy crops for a few years and then tend to disappear. The best old pastures contain a very permanent strain of perennial rye grass growing in conjunction with wild white clover. Seed of perennial rye grass taken from old pastures is permanent in habit and of great value for inclusion in a permanent seeds mixture.

Three strains of this grass bred at Aberystwyth are recommended for various purposes in long leys.

Cocksfoot.—A very large grass with characteristic flowering stems. It is a valuable grass, especially on lighter types of soil. The commercial strains are stemmy. Three Aberystwyth leafy strains are recommended for use in long leys or permanent pastures.

Timothy or *cat's-tail* has a flowering head which resembles a cat's tail. It is rather a late grass, but very productive on heavy or peaty soils. Commercial seed gives rather stemmy hay. There are three strains of Aberystwyth Timothy, one specially for hay and another for grazing.



(1) (2) (3) (8)

Red Clover (without ryegrass) from Saxmundham Heavy Land Experimental Station.

Plot (1) No manure for 40 years.
 „ (2) 10 tons of Farmyard Manure to wheat, in the rotation. The difference between this plot, and plot 1 is due to the residual effect of Farmyard Manure applied $2\frac{1}{2}$ years before this red clover was sown, and $3\frac{3}{4}$ years before the red clover was cut.
 „ (3) As plot (2), except that nitrate and superphosphate was applied to the mangolds, one year before the clover was sown. Compared with plot (2) this shows the residual effect of the super.
 „ (8) As (3) except that more superphosphate was applied in the rotation, some to the barley in which the clover was sown, and some to the clover direct.

Clovers and "Seeds" Mixtures.

The Clovers.

The Clovers form a group of very valuable plants, providing food rich in protein for animals. Like all leguminous plants they assimilate the free nitrogen of the air and in consequence enrich the soil. When, as is often the case, clovers such as wild white clover, occupy the soil for many years, the amount of fertility accumulated may be enormous, and it is probable that the general productiveness of our soils is due more to this than to any other single factor.

It is largely owing to wild white clover, growing in mixture with grasses that fertility has accumulated in our old "grass" fields, so that the top few inches of soil is often a mass of humus rich in nitrogen and full of partly decayed rootlets. This vegetable "mould" is of the greatest value and when the grassland is broken up is likely to result in good yields for many years, provided care is taken to grow suitable crops upon it, especially such crops as are unlikely to be affected by wireworms and similar pests which may be present.

Climate and Soil.

Most of the different kinds of clover will grow in the various climates of the British Isles provided soil conditions are suitable. The soil must be well drained and contain sufficient lime, phosphates and potash if maximum growth is to result. The idea that "clover will not grow in this parish," which exists in some districts, is very often due to unfavourable conditions—which can be easily rectified. Even on light sand in the driest part of England, the writer has obtained very heavy crops of red clover when plenty of lime was present in the soil. In a parish on the hills of the Cheshire-Derbyshire borders, 1,000 feet above the sea, "clover would not grow" until an enterprising farmer grew an enormous crop by applying plenty of lime and phosphates.

Place in Rotation.

Where clovers are grown alone, or as one-year leys in mixture with rye grass, they usually follow a cereal which has been grown on land cropped with roots the previous year. The clover seeds are sown or drilled in the growing cereal, and the small plants make comparatively little growth the first year but come to harvest about 15 months after sowing.

Manuring and Liming.

As previously mentioned, lime, phosphates and potash are very important to clovers. Nitrogenous manures are unnecessary. Farmyard manure and the residues of that manure applied to previous crops have been found at Saxmundham to have an extremely beneficial effect upon red clover grown alone. The following manuring is suggested for red clover or "seeds" mixtures:—

Heavy Land—Farmyard manure or—

4 cwt. 30% super or 5 cwt. slag ..	Applied to the young layers in autumn or winter.

Light Land—

Farmyard manure or—

1–2 cwt. 30% super 1 cwt. muriate of potash	Mixed together and applied to the young layers in autumn or winter.

Where the cereal in which the clover is sown follows a crop which has not received much phosphate and potash, the chance of getting a "plant" of clover will be considerably increased if phosphates and potash are applied before

sowing the clover and "seeds." As previously mentioned, clover is sensitive to lack of lime in the soil. The various clovers differ to some extent from each other in this respect but there can be no doubt that the failure of clover in certain fields has often been due to soil acidity and lack of lime. This failure of clover is a serious matter, since it has a most adverse effect upon soil fertility. Hence where a soil is poor in lime, immediate steps should be taken to put the matter right before clover is sown. If carbonate of lime can be distributed on the surface of the ground and harrowed in before the clover is sown, the seedlings will come in contact with it and a good "plant" may be obtained even though the soil below is still very acid. This happened at Tunstall Experimental Station in a very striking way a few years ago.

Species of Clovers.

Species.—There is a number of species of clovers commonly grown in this country:—

Red clover is largely grown in one year leys, either alone—as in the eastern counties—or in mixture with rye grass, when the mixture is known in many districts as "seeds." There is a number of strains of red clover of which the commonest are ordinary Broad Red—which gives two crops annually, the seed being taken from the second crop in September, and Late Flowering Red clover, which only gives one good crop, the seed being taken from this in July or early August. Red clover, either alone or in "seeds" mixtures, is usually mown for hay or silage in June, the second crop being either cut, or grazed. Broad red clover mostly dies out after the first harvest year, but some of the strains of late flowering red clover persist to some extent for another year or two.

Alsike clover is a useful plant to include in a "seeds" mixture. It has not so erect a habit of growth as red clover. It often succeeds well on heavy soils and occasionally persists to a second harvest year, especially in seasons of abundant moisture.

Crimson clover or "Trifolium" is grown mostly in southern and south-eastern England. The seed is drilled in August on the stubbles. Growth is very rapid and the plant is usually in flower at the end of the following May. It is not such a valuable plant as ordinary red clover, but is useful for sheep feed. It is also used for patching up indifferent layers of red clover. There is no second growth and immediately after the crop is removed the land is ploughed.

White clover.—There are several strains of white clover which differ widely in their properties and agricultural value. Ordinary or Dutch White is a biennial, like ordinary Broad Red clover. In the year of sowing the seed the plant establishes itself, and the second year it comes to maturity, after which many plants die. It produces a useful bulk of green fodder, which makes a very valuable sheep fold, and after breaking-up, is one of the best preparations for wheat. In mixture with rye grass, it makes an excellent one-year's grazing layer. New Zealand Certified White and Aberystwyth S. 100 are somewhat similar plants to the above in appearance, but they may last for 4 or 5 years. These clovers are most valuable for inclusion in two, three or four year leys, as they produce more bulk than does Wild White clover.

Crimson Clover growing on a very light acid soil.

(1) No chalk or manure.
(2) 10 tons an acre of chalk applied a few years previously + 2 cwt. Super. applied to the Trifolium.
(3) 10 tons an acre of chalk applied a few years previously. + 2 cwt. Super. / 1 „ Muriate of Potash } applied to the Trifolium.
(4) 10 tons an acre of chalk applied a few years previously + No other treatment.
(5) 10 tons an acre of chalk applied a few years previously + 1 cwt. Muriate of Potash to the Trifolium.

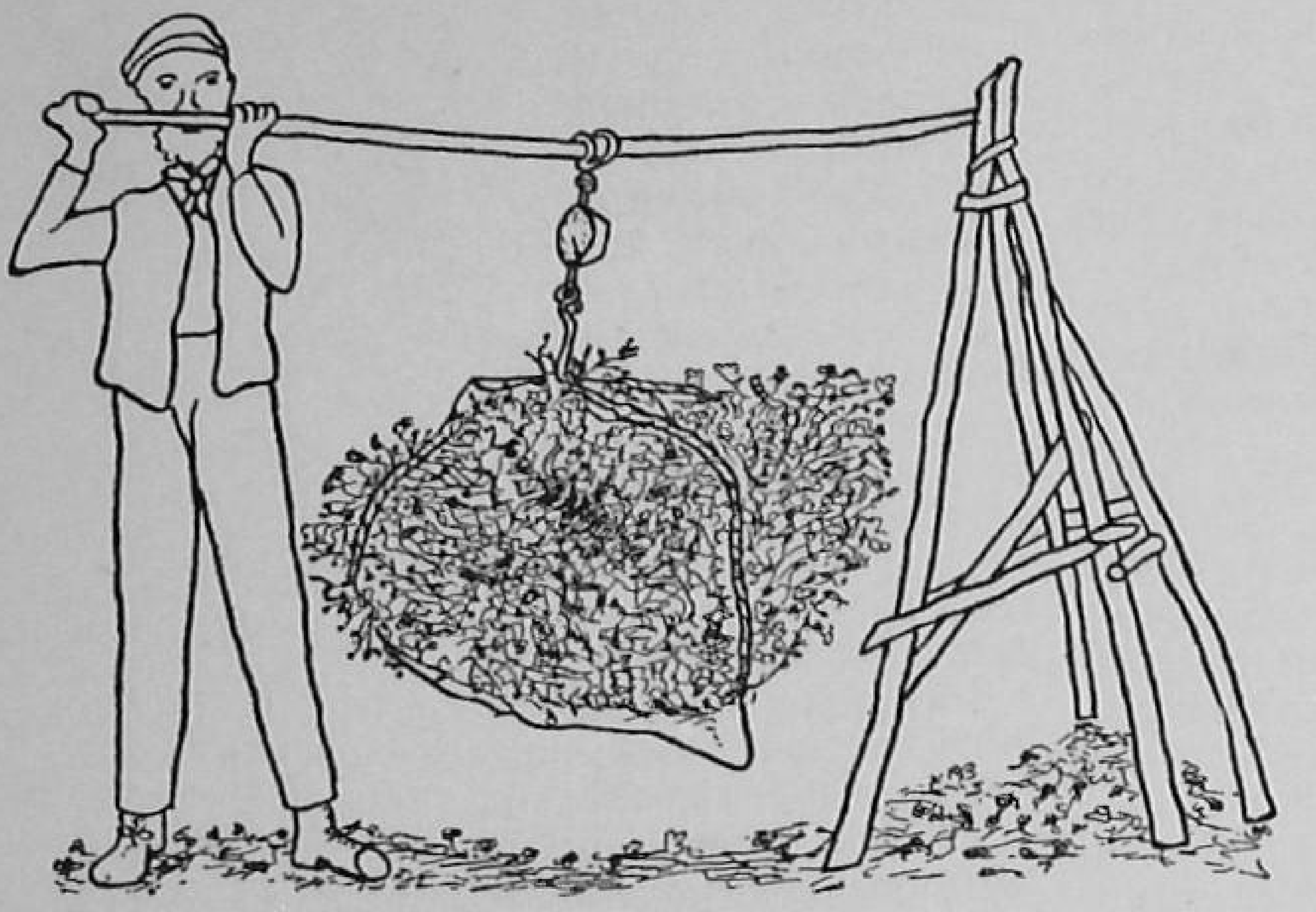
On very light soil phosphates occasionally cause the crop to mature too quickly and this seems to be the case in the above experiment, when plots (3) and (5) are compared.

Wild White Clover.

There are few more valuable contributions of science to agriculture than the recognition soon after the beginning of the present century, that wild white clover found in old pastures, was a widely different plant from the white clover commonly grown from seed at that time. By saving white clover seed from old pastures "Wild White Clover Seed" was first put on the market. Its great value and its immense superiority to ordinary white for anything longer than one year leys soon became evident. Wild white clover seed from old pastures soon reached very high prices, but the position has now been stabilized. The immense value of wild white clover lies in the fact that it persists and covers the ground like a carpet if soil and manurial conditions are

suitable. This greatly and quickly adds to the grazing value of pasture. At the beginning of the present century a farmer laying down a field to grass, of necessity merely included ordinary white clover, which soon died out and left the field with many blank spaces which usually took a number of years before they became covered by true wild white clover. The seed of this was probably brought in the droppings of animals from other pastures. Very often these blank spaces became covered not by wild white clover but by weeds.

The following figures from Saxmundham Heavy Land Experimental Station show the effect of the two kinds of white clover on the yield of hay. In the first year the ordinary white clover was slightly superior, but by the fourth year practically all the clover, both red and white, was gone from Plot 13, whilst Plot 12 contained much wild white and had a good " sole " or carpet of clover.



Saxmundham Experimental Station. Weighing plots of Clover.

YIELD OF HAY.

	lb. of seed per acre.	*1st harvest year Cwt. per acre.*	*4th harvest year. Cwt. per acre.*
PLOT 12.			
Ordinary perennial rye grass ..	24	73	40
Wild white clover..	2		
Late flowering red	6		
PLOT 13.			
The same seeds as Plot 12, only ordinary white clover instead of wild white ..		77	16

Kidney Vetch.

Kidney Vetch or Yellow Sand clover is not a true clover but is similar to the clovers in many ways. It is a most useful plant to include in mixtures for leys on light land. Sheep are very fond of it.

Trefoil.—A useful plant for sowing on land which is not very clean. The seed is cheap as a rule, and the crop is ready for use early in June. The land can then be broken up, fallowed and prepared for autumn wheat. Trefoil is usually folded with sheep, but is sometimes made into hay. It is rather short and probably does not produce more than half the crop given by red clover. It is quite commonly included on one year leys owing to the cheapness of the seed. Sown in barley, the growth obtained when ploughed in green in mid-winter has been found to help in keeping " Eye-spot " of cereals at bay.

Sowing the Seeds.

Clover seeds may be sown at the same time as the spring cereal in which they are to be grown, but this sometimes leads to the clover getting too forward, and results in difficulty in harvesting the cereal. More frequently, therefore, the clover seeds are sown when the corn is 2 in. or 3 in. high and they may be horse-hoed in or the land may be rolled and harrowed, these two operation covering the seed. It is very important to get the land well solid and, as a general rule, " plants " of clover are better on headlands than anywhere else in the field. In the drier districts of England clover seed is usually drilled, as it is more easy to secure a " plant " in this way. In other districts it is sown broadcast.

Quantity of Seed.

Quantity of seed per acre.—Broad red clover is often sown by itself in the south and east of England at the rate of 14 lb. seed or rather less per acre. Trifolium and kidney vetch are also sown alone at the rate of about 20 lb. per acre. Clover and grass or " seeds " mixtures differ very widely in different localities. The reasons for growing mixtures of grass and clover are—

(1) Clover alone is rather difficult to make into hay.

(2) Clover alone is apt to suffer from " clover sickness."

(3) It is more difficult to get a good plant of clover alone than of a mixture.

The disadvantage of including grass in the mixture is that grasses are allied to the cereals, and instead of enriching the land as do clovers, they impoverish it. After a crop of clover alone, the land is more enriched than after a mixture of grass and clover.

A typical mixture is—
10 lb. of broad red clover or of a mixture of clovers and 7 lb. of perennial or Italian rye grass per acre.

Changes may be made in the mixture in different seasons, according to the prices of the various clovers.

Perennial rye grass does not tend to smother the clovers as much as does Italian rye grass.

Utilization.

Well made clover or "seeds" hay is very valuable for most classes of stock, especially perhaps for horses. Clover alone, when made into hay in good weather, gives a fodder high in protein.

Clover and "seeds" leys usually yield heavier crops than is obtained from old meadows and crops of 2 tons per acre of clover hay are quite common.

In one very favourable season, a yield of 3 tons with the first crop and 2 tons with the second, was obtained at Saxmundham Experimental Station—total, 5 tons of clover hay per acre in one year.

Clover, or one year leys, perform a very useful function in the rotation. They provide a large bulk of very valuable fodder for farm animals—they relieve the pressure of work by providing an area which does not require to be ploughed and they enrich the land for the cereal following.

LUCERNE.

Valuable Forage.

Lucerne, or "alfalfa," as it is called in America, is a very valuable forage plant, which is, however, not grown as widely in this country as it might be with advantage. Given suitable soil and favourable climatic conditions, it produces an immense bulk of green fodder each year, usually in three cuts. Its deep roots, many feet long, render it capable of withstanding severe droughts, except on the lightest of soils and in extremely dry seasons. It occupies the land from five to seven years and during that period accumulates a great store of fertility which is available for succeeding crops. On light sandy soil at Tunstall, after seven years of lucerne, which averaged 3 tons of hay annually, and which was all carted off, 20 tons of sugar beet per acre were grown after the lucerne was broken up.

Lucerne is very rich in protein and lime, and hence gives most valuable fodder for animals.

Climate and Soil.

At present Lucerne is mainly grown in the south-eastern part of England, and as far north as Nottinghamshire; but it is probable that by adopting suitable methods of cultivation, it could be grown over a much wider area. In the opinion of the writer, it could be made immensely productive on our very lightest soils if irrigation were provided. A very frequent cause of failure with lucerne is soil acidity. If sufficient lime is not present that substance must be added before satisfactory crops can be grown.

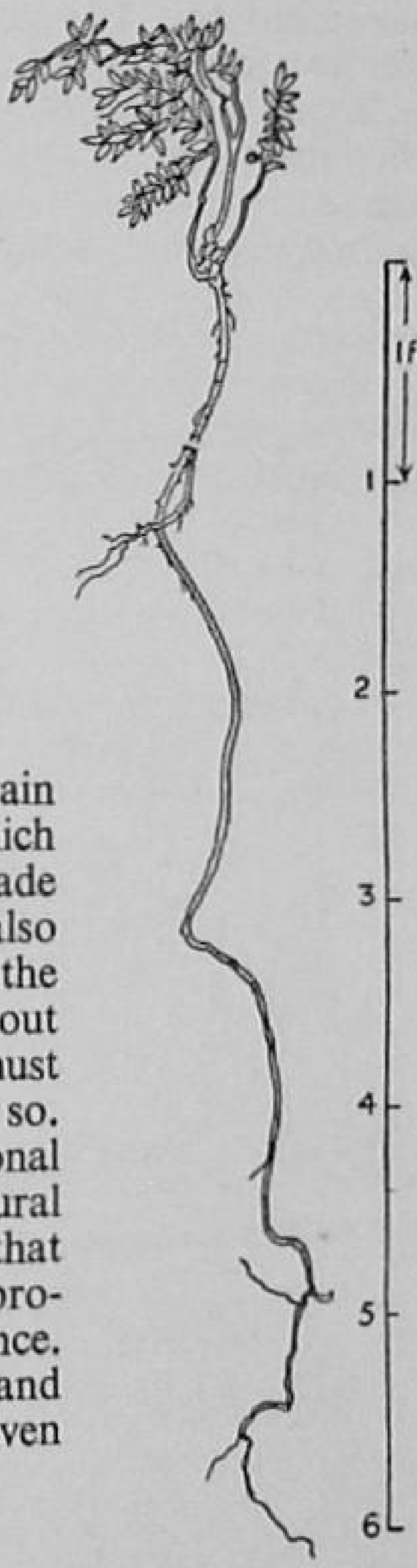
Lucerne will grow on quite heavy soil, provided drainage is adequate.

Preparing the Land.—It is useless to sow lucerne unless the land is clean. Where it is not, the land may be given a spring fallow and the seed sown later in the season, after a rain and when a good tilth has been obtained.

Sowing the Seed.

Lucerne may be drilled or broadcast. It is often considered best to sow without a cover crop but where this means losing one season's produce the question of sowing with a light seeding of spring corn should be considered. If the land is clean it seems a pity not to try this. The writer obtained good results on very light soil by drilling oats in wide rows 14 in. apart, with a seeding of 2 bushels per acre (half the usual quantity) and then drilling the lucerne between the rows of oats. A heavy crop of cereal grain smothers the lucerne, which is less tolerant of shade than is clover. It is also easily smothered by the shocks of corn standing out at harvest, hence these must be moved after a week or so.

Varieties.—The National Institute of Agricultural Botany has found that Grimm lucerne is more productive than Provence. Ontario, Variegated and Rainy River have also given good results.



A Lucerne root obtained from the side of a pit. Showing the great length of roots. The small rootlets extended much deeper than this.

Manuring.

Before sowing lucerne on heavy land a good dressing, say 6-8 cwt. basic slag or 4-5 cwt. 30 per cent super should be given. On light land 1 to 2 cwt. super and 1 cwt. muriate of potash should be applied.

After the lucerne has been down a year or two further dressings of these manures should be given.

On light land at Bramford an annual dressing of 1 cwt. of muriate of potash per acre, increased the crop of hay from 45 to 61 cwt. per acre. Some form of lime should be applied not less than one year before sowing the seed, if the soil is acid.

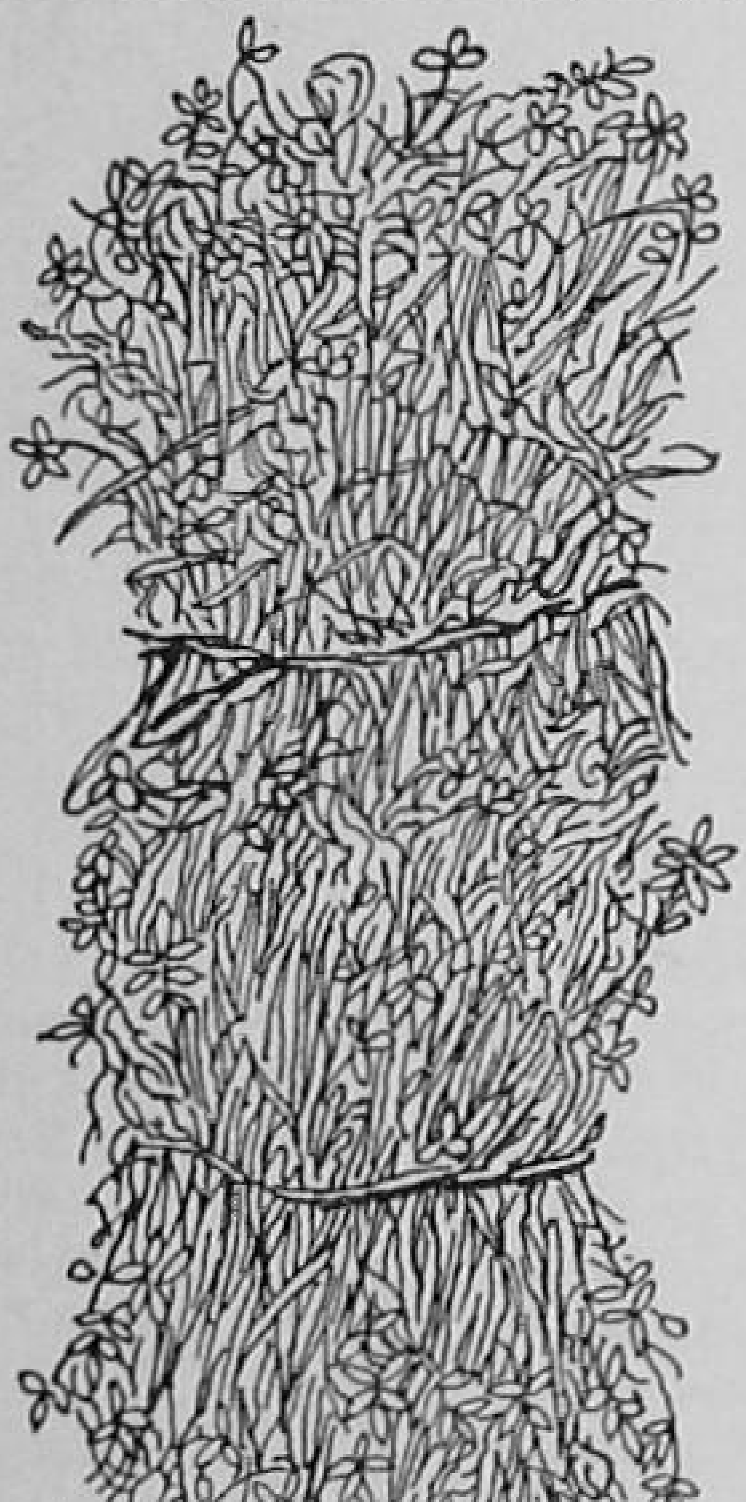
Inoculation of Seed.

Where the soil has not grown lucerne before it is very important that the seed should be inoculated with a culture of microbes (prepared by Messrs. Allen & Hanbury, Bethnal Green, London, E.2), as perfected by Rothamsted Experimental Station.

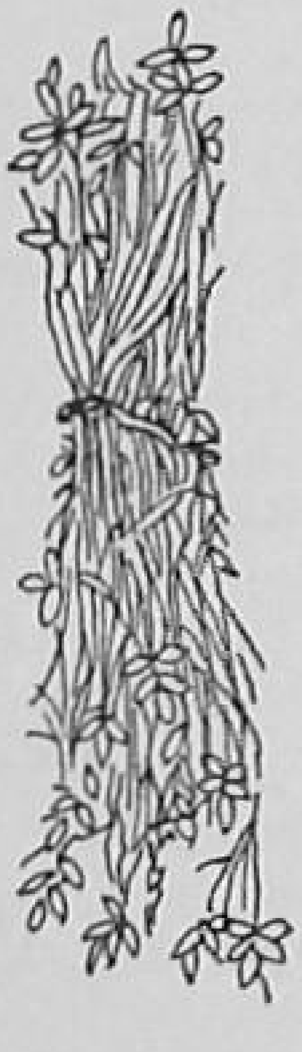
This culture supplies the micro-organisms necessary to enable lucerne to form nodules on its roots and so to assimilate nitrogen from the air. On fields where lucerne has been successfully grown, the right microbes are usually present. Where a soil has been very acid, but has been limed, it is very likely that inoculation will be necessary.

Sowing.—It is usual to sow about 20 lb. of seed per acre in this country, but some consider this is an unnecessarily heavy seeding. On light land, lucerne may be drilled in rows wide enough (say, 12 in. apart) to permit of horse-hoeing or other cultivation between the rows. This can easily be carried out on such land and will keep the lucerne relatively free from weeds, and in consequence much more productive.

On heavy land horse-hoeing is difficult so the seed is often broadcast. Some say that mixing a few pounds per acre of cocksfoot seed with lucerne helps to keep down weeds. Others say the cocksfoot tends to smother the lucerne. Two lb. per acre of broad red clover which dies out after the first harvest year, is a useful addition.



A bundle of lucerne. The seed was inoculated and the acid soil had received sufficient lime.



A bundle taken from the same area. The seed was *not* inoculated and the soil had no lime.

Treatment During Growth.

It is very important to keep the crop as clean as possible, especially during the first year. On light land with 12 in. rows it is possible to pass the plough down in late autumn to a depth of 2 in. to 3 in. and partially cover each row of lucerne crowns. In spring the lucerne is cross-harrowed, and this removes the soil and kills most of the weeds. This plan has been found very successful.

Alternatively, a horse-hoe may be passed down the rows and subsequent harrowings may be given. When late autumn and early spring cultural treatment has been given, the writer has not found it necessary to horse-hoe during the summer. The heavy shade of the lucerne keeps down weeds.

On heavy land these operations are more difficult and in wet seasons it is sometimes difficult to prevent *Agrostis* (water grass) from spreading over the whole. Where this happens and the crop begins to be unsatisfactory the only plan is to break it up.

Utilization.—Lucerne may be made into hay, It is best to make it into cocks before the leaves become brittle. Otherwise much leaf—the most valuable part—will be lost. Tripods (see Peas) are very useful. If the crop is cut at the early flowering stage protein content is high and fibre low. Silage may be made from lucerne, and from lucerne mixed with grass, and if molasses be added, the silage may be of very high quality. A friend of the writer made silage in a pit from lucerne and grass mixtures for 40 years in succession.

Lucerne is excellent for mowing and feeding to animals green. When artificially dried, it makes most valuable food material. Factories have been established to do this; the produce being ground up and sold as alfalfa meal for poultry. Artificially dried lucerne is extremely valuable as cattle food during the winter. One great advantage over dried grass is that in the drier parts of England it produces very much more food per acre. If lucerne is grazed like an ordinary grass field it tends to die out rather rapidly. It has been found, however, by the Duke of Grafton in West Suffolk, that it may be folded once a year by sheep, the other crops being mown. This does not cause it to die out. In mixture with cocksfoot it has also been grazed by cattle, on light land, the field being grazed bare, and then all the animals taken off to give the lucerne time to grow up again. Such a mixture is far more productive than " grass " on light land in a dry climate and very likely also in a moist one. A mixture of lucerne and sainfoin has been found very useful in Kent. A few pounds of lucerne per acre added to the seeds of a temporary ley increase its productivity and render the ley less liable to suffer from drought in a dry district. The principle of including deep-rooting, drought-resisting plants in grass mixtures was advocated by the late Mr. R. H. Elliott, of Clifton Park, Kelso. He used chicory, burnet and yarrow, but there can be no doubt that lucerne is also

suitable in districts where it will grow. As a forage plant it is much superior to chicory, burnet and yarrow as an ingredient in a mixture.

Sainfoin.

Valuable Forage.

Sainfoin is a very valuable forage crop, especially where chalky land prevails. A sufficient supply of lime in the soil is essential and where this is present, sainfoin will grow on quite light as well as on heavy soils. It is grown in the south and east of England as far north as Lincolnshire wherever the chalk comes near the surface. It may be grown alone or in mixture with lucerne or as an ingredient in a grass ley.

It belongs to the leguminous family and hence is able to obtain its nitrogen from the air. Ordinary Sainfoin is a smaller but more permanent plant than Giant Sainfoin. The latter may last for only two years, whereas a good strain of ordinary sainfoin may last several years if conditions are suitable.

Sowing.—Sainfoin is usually drilled in the same way as clover in oats or barley grown after roots. Four bushels of unmilled seed or 56 lb. of milled seed are required when sown without admixture of clover, lucerne, or grass.

Manuring.

If the land is poor in lime, a sufficient dressing of that material should be applied a year before sowing the crop, otherwise there is little hope of success.

Phosphates on heavy land and phosphates with potash on light land will usually be beneficial.

Utilization.

Sainfoin is extremely valuable for all classes of stock, especially for sheep. Sainfoin hay well made, and with all the leaf on, is especially valuable. It is also suitable for silage.

The hay may contain 7½ per cent of digestible protein with a starch equivalent of 33.

The second crop of sainfoin is usually grazed.

Vetches or Tares.

Useful Forage.

Vetches are a very useful forage crop, being grown for folding with sheep, for hay, for mowing green and feeding to cattle or horses, or for silage.

They are especially useful on poor land, whether heavy or light. Like other leguminous crops, they obtain nitrogen from the air, but they require a sufficient supply of lime, phosphates and potash in the soil. Good drainage is essential but when this is provided they will often grow surprisingly heavy crops on quite poor clay soil. They will also succeed for fodder on poor light soil, as the winter moisture is usually sufficient for this, but in a dry season they may fail to produce much seed on such soil.

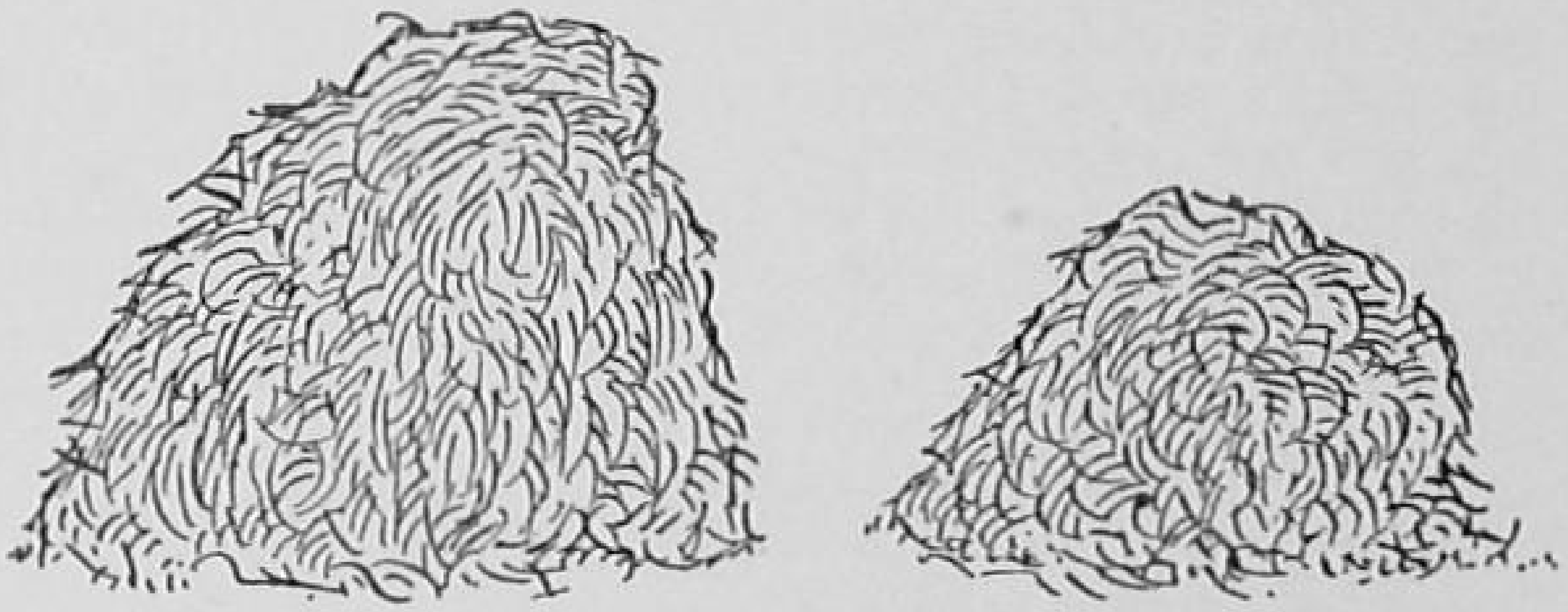
Preparing the Land.

Tares for forage are often grown on land which is not very clean, as after they are removed, it is often possible to make a "pin" or half fallow in July or August. The stubbles of the preceding crop are ploughed and the seed drilled or broadcast at the rate of 2 to 2½ bushels per acre when sown alone.

Winter tares are sown at the end of September or early in October. They are commonly grown in the southern half of England, whilst spring tares are favoured in the north and in Scotland.

Manuring and Lime.

Farmyard manure may be ploughed in and is very beneficial except, perhaps, when the crop is grown for seed. Failing farmyard manure, 5-6 cwt. basic slag, or 4 cwt. 30 per cent super on heavy land, or 2 cwt. 30 per cent super, and 1 cwt. muriate of potash, on light land will prove beneficial as a rule.



Lucerne *Old Grass*

Showing the relative productivity of Lucerne (64 cwt. per acre) and old grass (28 cwt.) for 4 years, in the same field.

Vetches are sensitive to lack of lime in the soil. That substance must be applied in some form if the soil needs it, before good crops can be obtained.

For Folding and Mowing.

Vetches for sheep folding and for mowing green.—By sowing at different dates, it is possible to secure valuable feed, suitable for use from early June to the end of July, or later. It is quite usual to mix early sown vetches with oats, as these tend to hold the crop off the ground to some extent.

A mixture of oats and vetches sown for mowing green or "soiling" for horses and cattle is essentially valuable, especially in dry seasons when grass is scarce. The chief disadvantage is the labour of cutting and carting small quantities every day.

Alone, or in mixture with oats, they are suitable for hay, provided the weather is good at the time of haymaking. They are very succulent and need a period of good weather to make into

really first class hay. Because it so seldom happens that the weather permits of really good vetch hay being made, the crops must be regarded as risky for this purpose. Tripods (see Peas) would be useful for hay, or for vetch seed.

Vetches for Seed.

When seed is to be harvested, it is best not to grow the crop on very rich land, as the haulm may get too luxuriant and very little seed may then form. Most leguminous plants usually give the best yield of seed from crops of moderate growth. When ripe the vetches are cut by grass mower with pea lifters attached, or by any of the mechanical methods suggested for peas. After a period of wet weather the vetches are often beaten down on to the soil and are then very difficult to cut.

When cut, the crop is put into " cocks " like peas and harvested loose as soon as thoroughly dry. A yield of 32 bushels of seed per acre is very good, and much smaller yields are common.

Vetches must be regarded as a most useful forage crop owing to their ability to grow on poor soils, and under widely different climatic conditions. Their greatest disadvantage is a trailing habit of growth which often involves much hand labour in harvesting them.

MORE FORAGE CROPS

Here Silage Crops first receive attention, and in this connection Young Grass, Arable Crops grown for the purpose and Sugar Beet Tops are passed in review. There follows a section on the growing of Lupins, which are discussed under the headings of Varieties, Manuring, Sowing the Seed, and Utilization. Finally, Maize as a forage crop receives attention.

Silage Crops.

A number of crops may be used for making silage, which may be defined as green forage preserved by keeping air and water from it. It has been known for two thousand years or more that green forage if buried (in such a way as to keep both air and water out) underwent certain fermentations which preserved it. Often such material has a most unpleasant odour, but in spite of this various farm animals will eat it and thrive upon it.

Young Grass.

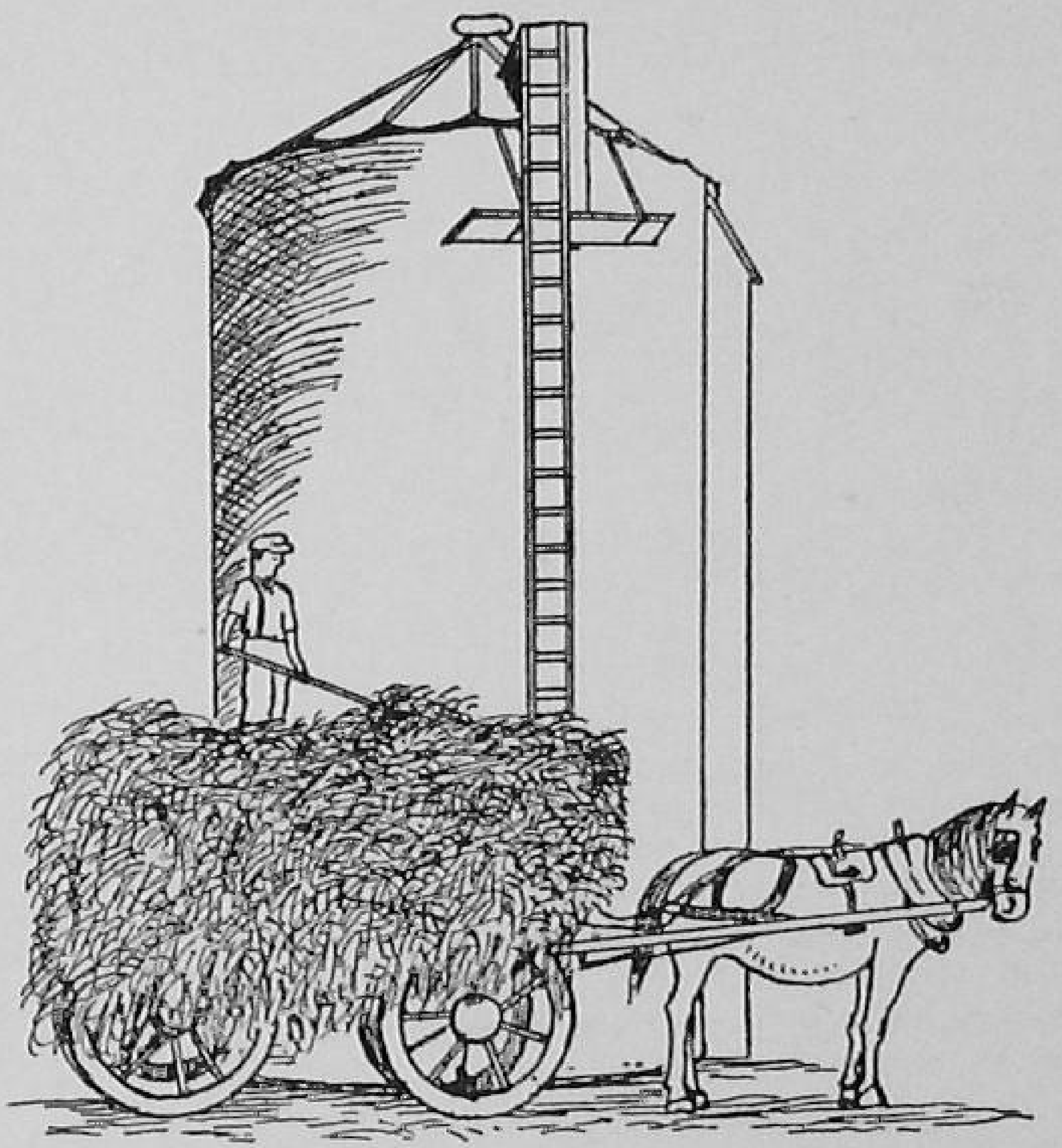
In recent years the practice of making young grass into silage has been much discussed. It appears that by adding molasses to such grass very high quality silage can be made, and that 20 lb. of such material, if fed to a cow contains enough food to produce one gallon of milk. If a farmer has 3 tons of such silage per cow he can produce milk throughout the winter with very little concentrated food. Unfortunately it is very difficult to get a sufficient supply of this very high quality silage. Grass which has reached a mature stage makes silage of a much lower quality.

Arable Crops.

Arable Crops for Silage.—Very valuable silage, although not of the highest grade, can be made from a number of arable crops without the use of molasses, and it is proposed briefly to refer to them, since they often produce much more food per acre than does grass, especially in the drier parts of England. Such material can be made into silage in tower silos or small cylindrical silos or it can be ensiled in a shallow pit or trench in the earth—in the last-mentioned case with practically no capital expenditure. It is beyond the scope of this book to deal in detail with the best methods of making silage. It may be mentioned however, that during the past few years great progress has been made in the mechanization of silage-making in trenches and there is a good deal of evidence to show that this is the cheapest method to adopt, both in labour and equipment. A few notes upon arable silage crops are given below. A suitable crop to grow must give the highest possible yield per acre, consistent with standing up, it must be unlikely to fail owing to season, it must be cheap to grow and it must be of high feeding value. If, in addition, after its removal, an opportunity is afforded to clean the land, so much the better. In the southern part of Britain it will usually be found that autumn-sown mixtures are best. On very heavy clay land Mr. W. S. Mansfield, Director of Cambridge University Farm, for many years used a mixture of:

2 bushels winter beans.
1 bushel grey winter oats.
And from ¾ to 1¼ bushels vetches.

This mixture is drilled in rows 18 in. apart in October. If possible a dressing of farmyard manure is ploughed in. Five cwt. of super phosphate, or 8 cwt. basic slag, is applied before drilling. The crop is horse-hoed once or twice in spring and is usually ready for cutting early in July. Such a crop needs chaffing before it is put into the silo. Where oats and tares are grown, without any admixture of beans, say 1½ bushels of tares and 1½ bushels of winter oats, the crop may be successfully ensiled in the long state in a shallow trench or pit. On light land a mixture of 2 bushels of tares and ½ bushel of rye was found best in Essex trials. The land must contain sufficient lime, or the tares will not succeed.



Putting a green crop—oats and tares—into a cylindrical concrete silo. The silage cutter and blower is behind the green stuff, and the pipe up which the chaffed green stuff is is blown, is behind the ladder.

In the northern and western districts spring-sown mixtures of beans, tares and oats have been successfully used. Such a crop is very suitable to grow on ploughed-up grass. In one case peas

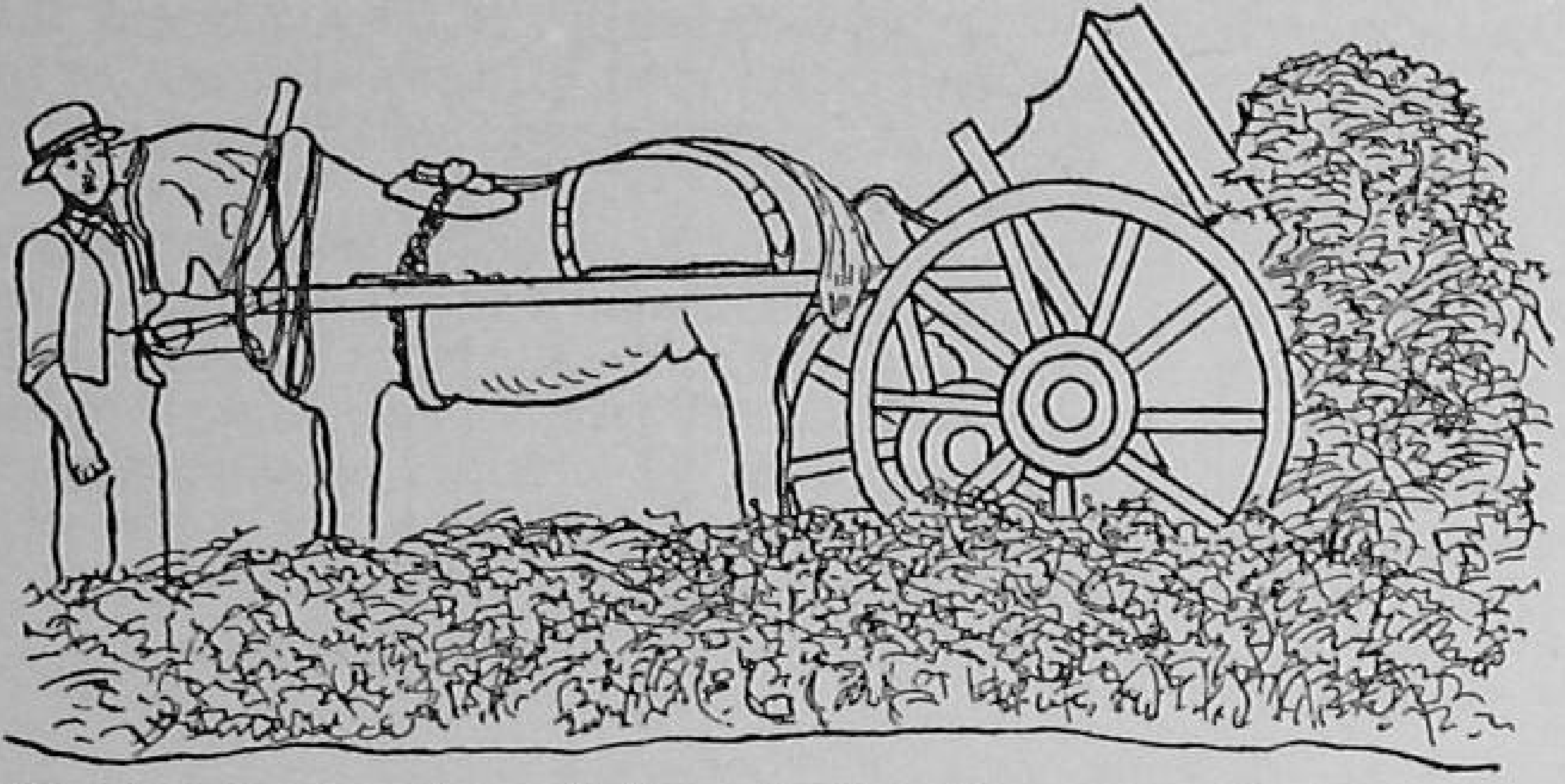
covered with aphides were made into silage most successfully.

Amongst other crops which are suitable for silage may be mentioned: Lucerne, sainfoin and clover and "seeds" mixtures.

Maize is very largely used for silage in America. In this country it is best chaffed and made into silage in a container.

Sugar Beet Tops.

Sugar Beet tops have been made into silage on a very large scale by a few farmers. They must be kept as free from soil as possible. They do not require chaffing but are merely carted to a large clamp or pit and covered up. Sugar beet top silage has a very objectionable smell, but for all that cattle thrive upon it. Where good drainage exists as on light land a trench 3 or 4 feet deep and 12 feet wide is a suitable size. The heap is carried upwards as far as possible—say, 5 feet—and rounded up before covering with earth. Where drainage is poor the heap should be made on the level.



Topping up a trench, or shallow pit silo with green stuff. The green material extends three or four feet below ground level.

LUPINS.

Lupins are not grown on an extensive scale in Great Britain, although an appreciable area is to be found in East Anglia. They are the only leguminous crop which will thrive on land seriously lacking lime. The soil they prefer is a light sandy loam, but they will grow remarkably well on blowing sand. They may be grown after any cereal crop, the land merely being ploughed and cleaned if necessary.

Varieties.—The lupins hitherto grown in this country have been mainly the Bitter Blue. Though Sweet Blue and Yellow Lupins have been developed on the continent the export of seeds into England was prohibited before the war.

A very small stock of the Yellow Sweet Lupins came into the hands of the writer in 1938. It was grown for seed until there was enough to sow an appreciable area in 1944. The Sweet Blue Lupin has proved extremely successful in New Zealand, and a small supply of seed has been imported into this country.

One of the varieties of Sweet Yellow-flowered lupins, "Weiko" has white seeds which are claimed to be suited to human consumption. All varieties of sweet lupin are very rich in protein.

Manuring.

The residues of farmyard manure applied to previous crops have had a beneficial effect upon lupins at Tunstall. No other manures had any noticeable effect. Lime applied in a quantity sufficient to make the soil alkaline is probably harmful.

Sowing the Seed.

When grown for seed production, drilling is best carried out in April, in rows about 14 in. apart. This permits of horse-hoeing. From 6 to 9 stones of seed per acre is a usual quantity. The seed should be put in on a firm seed bed, not too deeply. When sown for green manuring or for folding the seed may be drilled from April to July. Horse-hoeing should be performed as for beans. Harvesting for seed is carried out by the binder or the side-delivery reaper.

A good average yield is from 10–12 cwt. per acre, which, considering the poor type of land upon which the crop is grown must be considered satisfactory. Provided there is sufficient moisture, a large weight of green material is grown per acre, 10–15 tons.

Utilization.

Owing to the highly poisonous character of the herbage and grain of the Bitter Lupin, the utilization of this crop has been rather difficult. The bitter lupins are often folded by sheep which seem able to tolerate more of the poison than other farm animals. Much care must be taken, however that the sheep do not go upon bitter lupins when hungry. Bitter lupins are often grown for green manure, and on light land they are probably the best crop available for this purpose, and are usually followed by excellent yields of the succeeding crop. A crop of lupins for green manuring or folding may sometimes be obtained after another crop is removed or folded early, such as rye, trefoil, Trifolium or early potatoes. The sweet lupins previously referred to are spoken of very highly in New Zealand and in some experiments there at Canterbury Agricultural College lambs folded upon them gave nearly twice the live weight increase as compared with rape. It is hoped, therefore, that a sufficient stock may be obtained shortly to enable them to be thoroughly tried in this country. They gave satisfactory yields of grain at Tunstall, and grew well on acid land. If they succeed as well in this country as in New Zealand they will prove a very valuable light land plant.

Sweet lupins have been fed with success to farm animals in this country, both in the green state, and as grain. They have also been satisfactorily made into trench silage.

Maize.

Maize is a very useful forage crop, especially for southern and eastern England. It is mown green and fed to cattle in September and October. In most seasons a small area comes in very usefully indeed at a time when grass is quite often conspicuous by its absence, especially in the dry eastern counties.

The land is prepared as for swedes and generously manured with farmyard manure and nitrogenous artificials.

It is often convenient to grow a small area of maize near the homestead or near a pasture on to which the crop can be carted to the cattle in early autumn.

Sowing.

The moisture of the soil should be conserved as far as possible before drilling. Usually maize will grow an immense crop—20-40 tons of green stuff per acre—provided it is generously manured and there is sufficient moisture present. About the middle of May is a good time for sowing as maize is easily damaged by frost. The seed may be ploughed in by means of a bean drill in every second furrow, or it may be hand-sown down the furrows and ploughed in; or it may be drilled like beans with a cup drill. The land should be protected by means of string or cotton to keep off rooks which not infrequently ruin the crop.

Horse-hoeing is very desirable and kills many weeds.

Utilization.

The crop is usually cut by hand and carted on to pastures where it is eaten by stock. It is rather a watery carbohydrate food with about 15 per cent dry matter, but the feeding value varies with the season and variety.

White Horse Tooth Maize is watery, whereas the variety Jaune Gros du Domaine contains much more dry matter, and is a good variety for silage.

In favourable seasons it often happens that there is a larger crop of maize that can be fed before mid-October, when there is danger of frost cutting it down.

In this case, if a relatively small quantity is available, it may be cut and put in shocks in the field, when it will take little harm for two or three weeks. If the quantity is fairly large, it is best made into silage, being chaffed up and put into a suitable container or even into the corner of a barn.

ROOT CROPS AND CROPS RECEIVING SIMILAR TREATMENT

These pages are mainly about the Potato, the other Crops included in the heading being reserved for consideration on pp. 206–217, *but our author begins here by giving us some particulars about the general questions of Preparing the Land and the Benefit of Farmyard Manure. Turning to the Potato, he tells us about the best Climates and Soils for this crop and proceeds with directions for selecting and preparing " Seed." Varieties and their individual characteristics are discussed. Manuring and Lime, Planting and Treatment during Growth are explained. Next, the author takes up the principles and practices of Spraying. Lifting and Storing the crop are described, and when the subject of Yield has been given a little attention the section is brought to a close with a section about the Pests and Diseases that attack this very important crop.*

PRELIMINARY.

A NUMBER of crops are included in the above heading. Potatoes, sugar beet, mangolds, turnips, etc. All of these are cleaning or fallow crops and occur normally in the same place in the rotation. They usually follow and are followed by a cereal. They are all sown in the spring and usually the land is uncropped from August or early September when the corn is harvested, until the root crop is put in during the following spring. This interval, in favourable seasons, permits of a good deal of cleaning of the land.

Preparing the Land.

As soon as the stubbles are cleared in harvest it is usually desirable to start cultivations. After a late wet harvest, when the soil is very moist, often the best thing to do is to plough as soon as possible, not very deeply, to check the growth of perennial weeds such as couch grass and *Agrostis* and to cause weed seeds to germinate. If the weather turns fine the land may be worked about in September and October and many weeds may then be killed. If the weather continues wet the land may remain untouched until a second and much deeper ploughing is given in November or early December. If frosty weather occurs during the winter the tilth of the land will be greatly improved and a good winter mould obtained even on very heavy soils. If the land is dry after harvest it may be best to break it up by cultivators or by " riffling," i.e. ploughing without the breast, after which the land is worked about and as much rubbish as possible killed. The land may then be deeply ploughed in November or December. The actual cultivations given differ widely with the kind of land, the implements at the disposal of the farmer, and his ideas on the subject. Every effort should be made to kill as many weeds as possible, and then to leave the land deeply ploughed in order to " weather " during the winter and so get a favourable seed bed. In spring, when favourable weather occurs, further cultivation is given, in this case depending more upon the crop to be grown. The object is to kill the weeds, to obtain a good seed bed, and especially in the drier part of England, to conserve soil moisture. The first and third of these objects are more or less antagonistic. It is possible to work up the land in a dry spring and kill the weeds only to find that the soil is cloddy and dried out and that the root seeds will not germinate until rain falls, which may not be for some time.

On light land opportunities to clean the land may occur even during the winter months and a spring ploughing is usually given. On heavy land a spring ploughing may easily result in burying the winter mould and greatly reducing the chance of getting a good " plant " of roots.

FARMYARD MANURE.

Most root crops greatly benefit from farmyard manure. In the drier parts of England this is usually applied in autumn and ploughed in. Northern and western farmers often apply the manure in spring for roots, putting it in baulks or ridges, which they close upon it. These baulks are opened and closed by the double-mould board plough, and the work may be done by horses or tractors, the root crop being finally grown on the baulk or ridge.

Having briefly described the cultivations generally given to all root crops we may consider these crops individually.

POTATOES.

Potatoes are not, strictly speaking, a root crop, as the portion eaten is a tuber, being the swollen end of an underground shoot. The potato was introduced to Europe from South America about the middle of the sixteenth century. After a time its cultivation extended and in Ireland the people came largely to depend upon it as an article of food. The disease known as " Blight," or potato disease, almost entirely destroyed the crop in that country in 1845, and this was followed by a year of famine.

Climate and Soil.

Potatoes thrive in most parts of the British Isles. Probably the ideal summer is one of moderate temperature and rainfall. Warm, wet, and thundery weather in July and August is bad in that it encourages disease. The most suitable soil is a light loam, but heavy crops are often grown on lighter soil. Good crops may also be grown on heavy land but in a wet autumn they are difficult to lift.

Preparing the Land.

The general cultivations previously outlined for roots may be given. In spring the soil requires deep cultivation, and in most districts is ridged. Very often farmyard manure is applied between the ridges, the potatoes being then planted and the ridges closed. Artificial manure is also applied between the ridges before planting the potatoes. Occasionally, in very dry districts, potatoes are planted on the flat. Planting of maincrop potatoes usually takes place in April. Women and children often perform this work. Of late, considerable progress has been made with mechanical planters.

" Seed " Potatoes.

The dormant buds on the potato tuber, called " eyes," are mainly clustered at the " rose " end, which is really the tip of the swollen shoot or tuber. What is commonly called potato " seed," is not, of course, true seed from a botanical point of view, but a swollen underground stem. It is the custom to take smaller tubers for " seed " purposes, but when these are not available good results can be obtained by cutting large potatoes so that each cutting contains one or more good " eyes." With most varieties it appears that the best way to allow the cut surface to heal is to place the cut sets in a moist cool place for some days before planting. This allows the cut surface to form a skin.

Sprouting Potatoes.

Sprouting or " chitting " potatoes in special boxes.—Potatoes kept in a clamp send out white sprouts before they can be planted, the amount of sprouting depending partly on the variety and partly on the mildness or otherwise of the winter. This sprouting exhausts the energy of the potato, as these sprouts are easily broken off or damaged. It has been found that if seed potatoes can be kept where light has access to them, and also maintained at a temperature well above freezing point, they send out short sturdy and coloured sprouts. These do not break off if reasonable care is taken in planting.

In the case of early potatoes, an earlier and also a larger crop is obtained. In the great potato-growing districts of Lincolnshire and elsewhere the seed of maincrop potatoes, as well as those of earlies, is sprouted in this way, large glass-houses being used for this purpose. The object is not so much to obtain an earlier as a larger crop and one of better quality. This plan also renders later planting possible, and this may be a great advantage when the land is not in very good condition—more time is available for cleaning and for giving thorough cultivation. It also renders possible the rejection of individual tubers which do not sprout and which would in consequence, lead to " blanks " if planted. Experiments in Ireland, Scotland, Lancashire and Yorkshire have shown different increases in crop per acre, due to sprouting; in Ireland of 2 tons, 13 cwt.; in the west of Scotland, 2 tons, 19 cwt.; in the East of Scotland, of 1 ton, 14 cwt.; in Yorkshire, of 1 ton, 19 cwt., and in Lancashire, of 1 ton, 7 cwt.

Sprouting of seed potatoes is best carried out with the aid of special boxes, which are stacked in tiers with the light gaining access to them. These are carried to the field and the potatoes planted direct from them. Some growers have large quantities of these boxes.

Change of Seed.

Especially in the warmer and drier parts of England aphides or plant-lice on the haulm in summer, carry virus disease of the potato, such as *leaf curl* and *mosaic.* In the northern parts of Great Britain and in districts of high altitude these pests are much less troublesome than in the south and midlands. This is the explanation of the fact which has long been known that Scotch, North country or Irish seed are much more vigorous and usually give heavier crops than does south country seed. It has also been found that if a virus-free stock of potatoes is obtained and grown in a wind-swept district of high altitude, the crop from it gives satisfactory and vigorous seed. Skilled potato-growers take great pains to obtain seed from suitable districts. Unfortunately smaller growers and allotment holders sometimes do not realize the importance of this matter, and in the same parish one may see the fields of skilled potato-growers presenting a most satisfactory growth whereas the amateur potato-grower has diminutive and miserable plants in his patch. Unfortunately also, the small grower often has a difficulty in obtaining the small quantity of really first-class seed which he requires at reasonable price. Every facility should be afforded to those who obtain first-class seed, to sell the produce as " once grown from Scotland " to their smaller neighbours. In many cases seed " once grown " from Scotland gives almost as good results as it does the first year from Scotland. Change of seed is less important in the case of first early potatoes if they are carefully selected and sprouted in boxes. There is probably no other single factor which has so great an influence upon the potato crop as the choice of satisfactory seed. Official certificates are issued by the Government Department concerned; regarding potato seed. A key to the meaning of these is given in a leaflet issued by the National Institute of Agricultural Botany.

Size of Seed.

Large seed probably gives a larger crop of smaller potatoes. When, as is usually the case, really good seed has to be brought some distance and is rather expensive, it is better to use seed about the size of a hen's egg. When the selected " seed " is rather large it may be cut, provided precautions are taken to allow it to remain in a

moist cool place for a time before planting. As a rule, if reasonable sized " seed " is used, 15 to 16 cwt. per acre is enough.

Wart Disease.

This disease, which lives in the soil and causes a warty growth to appear on the tuber, only affects certain varieties. All difficulty regarding it can be surmounted by growing immune varieties.

Varieties.

The number of varieties of potatoes is so large that it is impossible in the brief space available to consider any but a few of the best varieties from the point of view of crop and quality.

FIRST EARLIES.

Arran Pilot (immune to wart disease) is confidently recommended, the tubers are of excellent shape, the skin is white, the eyes shallow, and the cooking quality good. When allowed to mature very heavy crops are obtained, and it may be used as a second early.

Epicure recovers from the effects of frost readily, and is less influenced by virus disease than other earlies.

Ninety Fold and *Duke of York* are also well-known early varieties.

SECOND EARLIES.

Great Scot (immune to wart disease) may be used as a second early, but it gives a very heavy yield and is often used as a main crop. It grows a very vigorous haulm and is suitable for poor land. The quality is good. *Dunbar Rover* (immune to wart disease) is a recent introduction which matures at the end of August. It is of excellent quality and is a good cropper.

LATE OR MAIN CROPS.

The National Institute of Agricultural Botany groups these in order of cropping capacity as follows:

Arran Banner (immune to wart disease) is a heavy cropper of good cooking and keeping qualities. A white round potato with medium eyes, it can be relied upon to produce two or three tons more per acre than *King Edward.*

Arran Consul (immune to wart disease) develops its foliage late, but is a very heavy cropper, and is of excellent keeping quality.

Dunbar Standard (immune to wart disease) is a recent introduction. The tubers are kidney in shape with shallow eyes and white skin. It is a good cropper of excellent cooking quality.

Majestic (immune to wart disease) is a very good cropper and is probably the most widely grown white variety. The quality is good.

Red Skin (immune to wart disease) is a recent introduction. It crops well and is less coarse than *Kerr's Pink*. It also matures three weeks earlier and is not as prone to second growth as that variety.

King Edward is still very widely grown. The crop obtained especially on certain soils is much smaller than that of the varieties given earlier in the list. It is not immune to wart disease. By many it is considered to be of better cooking quality than most other varieties.

Manuring and Lime.

Few, if any, farm crops benefit more from a fair dressing of farmyard manure—10 to 15 tons per acre—than do potatoes, and whenever possible this should be applied. It is probably impossible to obtain the maximum crop of potatoes with farmyard manure alone, even in very heavy dressings, and it is best to use a suitable dressing of artificials in addition. When growing potatoes on a large scale the artificial manure is often sown by a combined manure distributor and ridge or drill opener, which carries out both operations at the same time. During the two great wars potatoes have been found to be a suitable crop to grow either as a first or second or third crop after good grassland ploughed up. They are also sometimes grown after clover. Under these conditions the land is likely to be richer in nitrogen than ordinary arable land. The quantity of nitrogenous manure used must be regulated according to the condition of the soil. An excess of nitrogen leads to too much haulm. The following suggestions must be regarded as suitable for average conditions and are subject to modifications, less nitrogen being required on soil rich in nitrogen. As a rule, phosphates are less important on light soil and potash on heavy soil.

Heavy Land.—Farmyard manure up to 15 tons per acre if possible ploughed in during the winter and

2 cwt. sulphate of ammonia 4 cwt. super 30% . . . . 1 cwt. sulphate or muriate of potash	Mixed together and applied in the baulks before planting.

Light Land.—Farmyard manure up to 15 tons per acre:

2 cwt. sulphate of ammonia 2 cwt. super 30% . . . . 1½ to 2 cwt. sulphate or muriate of potash . .	Mixed together and applied in the baulks before planting, or if potatoes are put in on flat ploughed in with the seed.

When farmyard manure is not available the above artificials may be increased by one-half, or even more.

It is often assumed that potatoes do not require lime and it is true that they can endure a mild

degree of soil acidity; but when the acidity reaches a point which differs considerably in different seasons the yield of tubers may be seriously affected. This has been shown in a very striking way at Tunstall Experimental Station, where, in certain years, the chalked part of the field has yielded more than double that of the unchalked.

Planting.

The modern large-scale potato grower uses tractors to open three "ridges," "baulks," or "drills" at a time; these being closed with the same implement, after sowing artificial manure and planting the potatoes. In order to hasten matters at such a very busy time of the year the farmyard manure is often applied and ploughed in during winter. If this is not done, the older custom of putting manure in the ridges and teasing it out by hand-fork is adopted. When a tractor is used the baulks or ridges are often made 30 in. wide, the potatoes being planted 12 in. to 15 in. apart in the rows. On smaller farms the ridges are opened by the ordinary horse-drawn double-mould board plough, the ridges being made from 24 ins. to 30 in. apart, this depending upon the cleanliness and richness of the land and whether the variety of potato grown has large or small tops. Plenty of room between the rows renders inter-cultivation more easy and it also enables large tops to have full opportunity to spread out without getting unduly crowded.

Of late, much attention has been given to potato planting machines which are gradually reaching a very high state of perfection.

Treatment During Growth.

The potato crop affords considerable opportunities for cleaning the land. A short time before the potatoes come through, harrowing will kill many seed weeds. Horse-hoeings and hand-hoeings then follow, depending both upon the weather and upon how much rubbish is present. It is usual to give a final earthing up with a double-mould board plough before the tops are so tall as to suffer injury. On light soil in dry districts, it is better to leave a V-shaped hollow at the top of the ridge or drill to catch the rain.

Under very dry conditions and where the crop is grown on the flat, care must be taken not to earth up in dry weather or moisture will be lost. If drought prevents earthing up, a few tubers may be spoiled owing to greening but this is better than letting the drought into the soil.

Spraying.

As a preventive against potato disease or blight, the haulm of potatoes is sprayed two or three times, usually in July. This operation is almost universal in Ireland and very commonly carried out in the damper parts of Great Britain and also in the fens. In the drier parts of England where there is often little blight spraying is not so common. In a district of moist warmth in summer spraying is almost certain to give a satisfactory increase of crop, and to reduce the proportion of diseased tubers. In districts where the atmosphere is usually drier it is only in moist seasons in which definite benefit results. In the west of Ireland and in some seasons elsewhere spraying may make the difference between a crop and no crop.

For many years it has been customary to use Bordeaux or Burgundy-mixture for spraying, made up as follows:—

8 lb. sulphate of copper.
4 lb. quicklime or 10 lb. washing soda.
40 gallons of water.

This mixture being applied at the rate of 120 gallons or so per acre. Knapsack sprayers on small farms and horse- or power-drawn sprayers taking three, five or even seven rows at a time are used on larger holdings. Owing to difficulties in obtaining this rather considerable quantity of water in a reasonably clean condition, it has become increasingly the custom of late to use dry sprays which are applied by a dusting machine when the dew is on the plant. It is doubtful whether this is as satisfactory as the wet spray. Whatever method is adopted, it is important that as far as possible the whole of the haulm be covered with spray, especially on the under side of the leaves. Spraying is now undertaken by specialist contractors.

Lifting.

Main crop potatoes are ready to lift when the skin does not rub off easily, the date depending upon season, variety and district. The methods of lifting differ widely according to the area of potatoes to be lifted. In gardens and allotments they are lifted by the fork. Relatively small areas may be lifted by the plough, preferably fitted with potato lifting attachment or some other device to prevent injury to the tubers. Drawing a cultivator across the rows has been adopted by some. During the second great war many farmers who had not the potato-lifting equipment usual in potato districts have grown potatoes, and they have been compelled to adopt any means they could think of. Provided the tubers are not injured, and as large a proportion as possible is brought to the surface, it does not matter what implement is used to lift them. Potato "spinners" are used by those with larger areas to lift as are also the recently introduced diggers with elevator platforms. These special implements require a considerable number of pickers to keep them going; they may be drawn by horses or tractors. After the potatoes are picked up a harrow should follow to uncover any buried tubers before the digger comes round again.

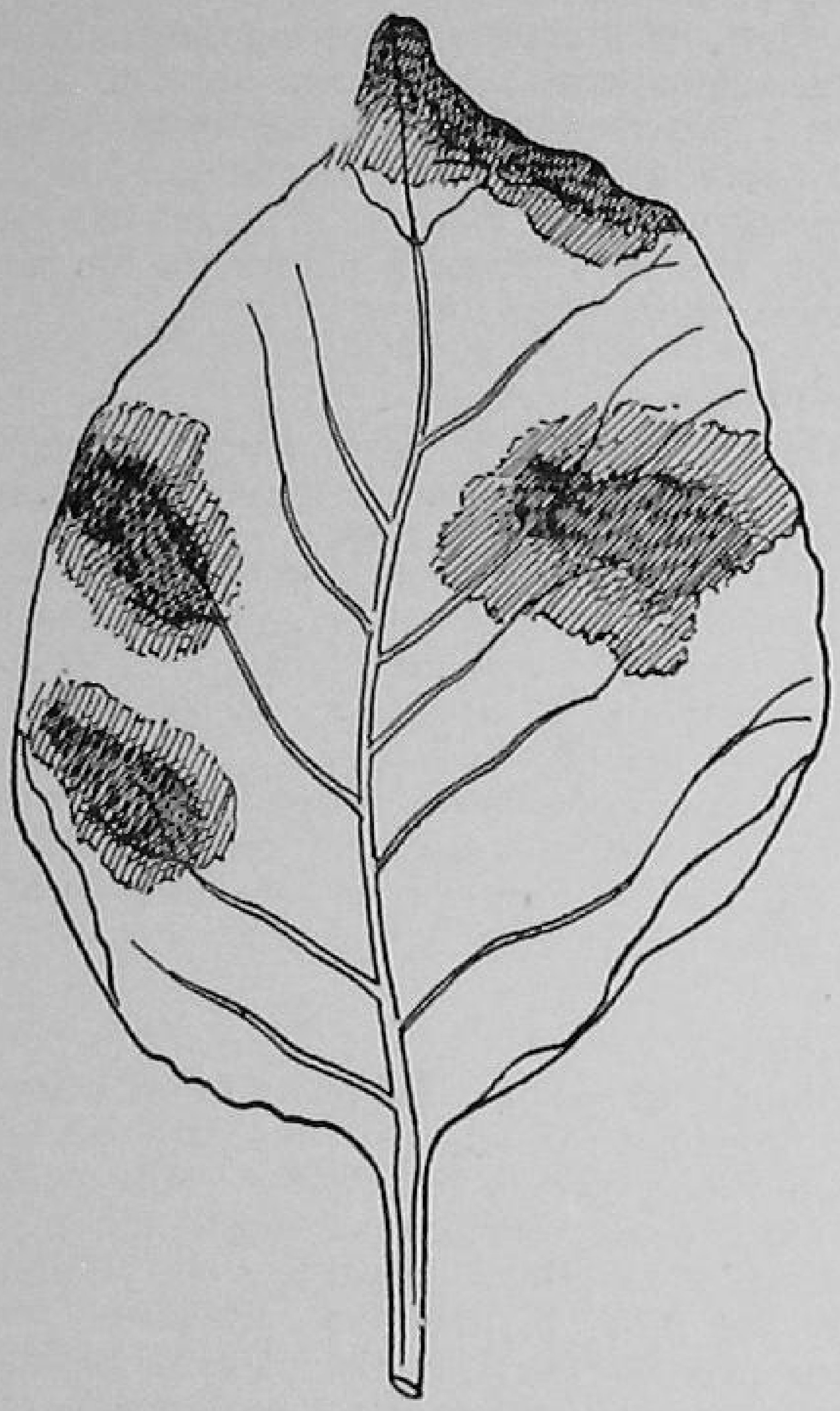
With 14 to 20 pickers and 2 or 3 horses and carts, and with men to take away the potatoes,

and 2 men at the clamps, it is possible to clear the ground of potatoes at the rate of 4 acres a day.

Much ingenuity is being devoted at present to devising a machine which will not only dig but also bag the potatoes, but the presence of stones in most soil renders this a very difficult problem.

Storing.

When a small area only is grown, potatoes may be stored in a brick or stone-built barn. The



Potato blight.
The underside of a potato leaf showing characteristic dark blotches of the disease in its early stages.

heap is left uncovered as long as the weather keeps mild. When frost comes, a good layer of straw is put over them. These potatoes being under cover, can be sorted over on wet days. Where a larger area is grown, the potatoes must be pitted or clamped. On light soil, a long shallow trench is made and the potatoes are carted into it and packed into a clamp shaped like the roof of a house. On heavy soil the clamp is best made on the surface without any trench. Straw to a depth of 6 in. (preferably arranged like thatch) is placed on the potatoes so that the wet will run off and not penetrate the clamp. The clamp is covered with earth to a depth of 9 in., but it should not be closed at the top for 2 or 3 weeks, or the potatoes will not keep so well. About the middle of December it is a wise precaution to place hedge trimmings or rough grassy material on the top and around the earthed-up clamp to keep off wind frosts.

Yield.

Very different yields of potatoes are obtained. With skilful cultivation under good conditions crops up to 16 tons per acre or even more are on record. Ten tons of marketable potatoes must be regarded as a good crop.

Human Food.

Potatoes as a food.—Potatoes share with sugar beet the distinction of producing more human food per acre than other farm crops. The energy value of an average crop of potatoes is more than twice as great as that of an average crop of wheat and about 3 times as great as an average crop of oats.

As Sir Thomas Middleton said, " One acre of wheat will keep 82 men for a week, one acre of oats 64 men, and one acre of potatoes 184 men." It is for this reason that during the second great war strenuous efforts were made by the Ministry of Agriculture to secure a very large crop of potatoes.

Insects and Fungous and allied Pests and Diseases.—In this country relatively very little damage is done by insect pests to the potato crop. Where many wire-worms are present in the soil, these damage the tubers seriously by boring into them, so rendering them unsuitable for human consumption.

The Colorado beetle is a very serious pest on the continent of Europe. Active measures have been taken by the Ministry of Agriculture to prevent its spread to this country.

Eelworm is a very serious pest in soils where it occurs and may altogether prevent the growing of potatoes. It is usually found where potatoes are grown too frequently on the same land. It may be introduced in contaminated seed and strenuous efforts should be made to prevent the use of such seed.

Virus Diseases.

Leaf Curl and Mosaic are carried by aphides or plant-lice from plant to plant. The virus affects the tubers, and if affected tubers are planted they produce feeble plants and yield little or no crop.

As previously explained, aphides are less common in Scotland and in northern districts and wind swept high-lying areas. If carefully selected seed is grown in such areas and rogued when growing to remove virus-infected plants, seed reasonably free from virus can be obtained.

Blight.

Potato Disease or Blight.—This disease which was responsible for the Irish Potato Famine,

attacks first the leaves and finally the tubers of the potato causing them to rot.

The attack on the leaves is much more virulent in damp warm seasons, especially in western districts. It sometimes appears on the leaves very early in the season in western Ireland. If the weather continues damp and warm it rapidly spreads and causes the leaves and tops to decay. If this happens before many tubers are formed the crop may be greatly reduced—in fact, may be almost nil. In most parts of England this early spread of the disease on the tops seldom occurs. More commonly the characteristic black spots appear on the leaves later, and it is not until August that the haulm gradually becomes seriously affected. Heavy rain, then, very often washes the spores of the disease down to the tubers, some of which go brown and finally become partially or wholly rotten. There are thus two different aspects of the disease:—

(1) Reduction of the crop owing to destruction of the tops. This is most serious in western districts.

(2) Decay of the tubers owing to attack of the disease.

The preventive measure is to spray the haulm, an operation which has already been briefly described.

So effective is spraying in preventing the attack of blight upon the leaves and haulm that, in districts where the disease usually appears, this operation has become almost universal. In such districts it usually results in a very large increase in the crop.

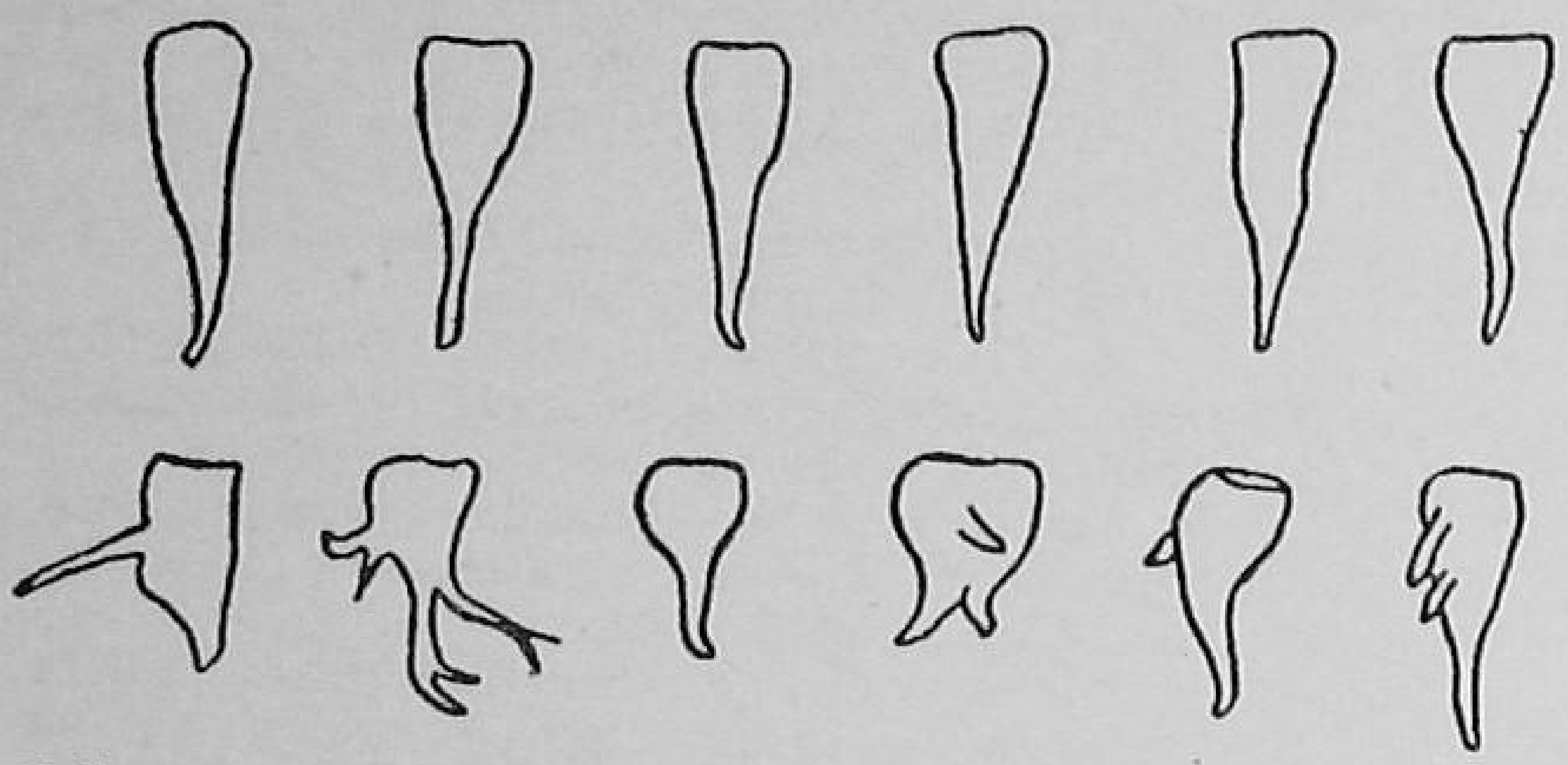
Of late, the practice of spraying the haulm with dilute sulphuric acid in late September to destroy both it (together with the spores of the disease) and weeds in the crop, has been adopted by large growers in certain districts. This renders lifting easier, and may possibly reduce the spread of disease amongst the tubers.

Wart Disease.

This disease, which causes a warty growth on the tubers of certain varieties, may be prevented by growing immune varieties.

ROOT CROPS AND CROPS RECEIVING SIMILAR TREATMENT—*continued.*

In the last section the Potato was given close attention. Here we are first of all introduced to the Sugar Beet, an important crop; the following points are considered: Climate and Soil, Place in Rotation, Preparing the Land, Strains and Varieties—" the most scientifically bred plant in the world "—Manuring and Lime, Sowing the Seed, After-cultivation and Lifting. The author also considers the by-products and their utilization and adds a note on Pests. For Mangolds, Swedes and Turnips, Cabbages and Kale (Brassicas), Kohl Rabi, and Rape he adopts similar treatment indicating in each case the particulars that are of importance to the farmer in preparing for the crop, growing it and using it.



Soil must have enough lime in it, otherwise it will not grow sugar beet. The upper line shows the shapes of sugar beet grown on land which had received chalk 7 years before.

The lower line shows beet grown on land which had received chalk 4 months before the beet were drilled. In this case the effects of the chalk were very incomplete. There was no crop at all, on the unchalked land.

SUGAR BEET.

" Thank God we have got the sugar beet now. You are providing, as a result of the sugar beet industry, the whole of the sugar that is necessary to meet the domestic ration."

Lord Woolton at Ipswich, 17th July, 1943.

New Crop.

As a comparatively new crop to British agriculture, sugar beet has made remarkably rapid progress since the first great war. This was due to Government assistance, the great value of the crop to the country being generally recognized. If the cultivation of sugar beet had not been encouraged, Great Britain would during the second great war have been either without sugar or would have been compelled to attempt to import it through submarine-infested seas. Sugar beet has a very favourable effect upon the agriculture of a district, in that it encourages thorough cultivation. It also, through the tops and dried pulp from the factory, provides valuable food for live stock as well as furnishing a considerable sum of money per acre to the grower.

Climate and Soil.

Most of the Lowlands in England, in eastern Scotland and in southern and eastern Ireland, provide climates suitable for sugar beet. Probably the ideal summer is one of moderate rainfall, with sufficient dry weather to enable the cultivations to be done efficiently and a fair, but not a too high, temperature. Frost the previous winter helps greatly in obtaining a good tilth. Very severe drought in spring sometimes renders it difficult to get a satisfactory plant. A severe drought in summer also reduces the crop, especially on light land. A wet summer may result in poor crops on heavy land. The ideal soil is a deep easy-working loam free from stones. Heavy crops have, however, been grown on most kinds of soil, ranging from blow-away sands to stiff clays. A wet autumn renders the lifting of the crop a difficult matter on really heavy soil.

Sugar beet is extremely sensitive to lack of lime, and it is hopeless to attempt to grow it until any deficiency of lime has been remedied. A water-logged condition of the soil is equally fatal.

Place in Rotation.

Sugar beet usually takes its place in the root shift, after a cereal. It may, however, be grown after various crops, but sugar beet should not normally follow sugar beet or mangolds owing to the fact that this tends to encourage diseases. The heaviest crop ever grown by the writer—20 tons of washed beet per acre—was on light sandy soil after seven years of lucerne.

Preparing the Land.

The normal cultivations for roots as outlined at the beginning of the last section are usually given. It is important that one of the ploughings should be a deep one, and sub-soiling is an advantage if a " pan " exists just below the depth to which the plough usually penetrates.

Manuring and Lime.

If farmyard manure is available, a moderate dressing of 10 to 15 tons per acre should be applied to heavy land and ploughed in before the last deep ploughing during late autumn or early winter. On light land it may be applied in very early spring. The following manures are suggested as a result of much experimental work on the subject:—

Ten to fifteen tons farmyard manure on all soils with additions as follows:—

	Cwt. per acre			Time of Application
	Heavy Land	Medium Soil	Light Land	
Sulphate of ammonia ..	2	2	1	At drilling of seed.
Nitrate of soda or nitrate of lime or "Nitro-Chalk"	1	1	2	At drilling of seed.
Superphosphate 30%	4	3	2	Before drilling.
Muriate of potash	Nil	1	2	Before drilling.
Agricultural salt ..	2	3	4–5	A month before drilling seed.

Where farmyard manure is not available, the need for phosphates on heavy land and for potash on light land is more pressing. Sugar beet is a maritime plant and common salt has been found to act as a true plant food for it: in fact, in the Rothamsted experiments 5 cwt. of salt per acre gave about its own weight of additional sugar.

Sugar beet is extremely sensitive to soil acidity and lack of lime. In the early years of the growth of sugar beet in this country many complete failures of crop resulted from the fact that this was not generally known. When the soil is not sufficiently acid to give a complete failure, losses of several tons per acre may occur owing to inferior plants due to this cause. Acid soils should receive a sufficient dose of some form of lime, if possible, a year before the crop is grown, otherwise the lime may not have time to become thoroughly incorporated into the soil. (See Liming, page 154).

Normally sugar beet seed is drilled in late March, in April or even in early May. Early drilling has been found to give the best results provided the land is clean. The second and third week in April are very suitable times, given average weather. The second week in May is late. It is an advantage to drill at intervals, so that the whole area does not want singling at once.

Strains and Varieties.

The "seed" of sugar beet is really a cluster of seeds enclosed in a hard seed coat. Continental workers have for the past hundred years devoted much skill to the production of a root which will give a heavy crop with a high percentage of sugar, and since sugar beet became important in this country British workers have taken the matter in hand. The sugar beet is stated to be the most scientifically bred plant in the world.

Many of the varieties and strains grown have originated on the continent, but the seed of most kinds has been grown in this country for some time, and the trials carried out by the National Institute of Agricultural Botany show that English-grown seed fully maintains the standard of tonnage and sugar yield given by continental-bred strains before the second great war.

Sugar beet strains fall more or less into three types, known as "E," "N," or "Z."

The "E" type has high root yield with a reasonable sugar content.

The "N" type is intermediate in character.

The "Z" type aims at high sugar content. It usually gives a rather smaller crop of roots.

Amongst the best of "E" type may be mentioned: *Sharpe's Kleinwanzleben E.* The yield of roots and sugar per acre being seldom surpassed by other strains. *Johnson's Perfection E.* Derived from *Kuhn E*, gives a little higher sugar content than *Klein E.* Other satisfactory strains are *Cannell's No.* 22, *Battle's E, Garton's C, Bush E, Cannell's* 937.

N. Type.—Johnson's Perfection (*N*), *Webb's No.* 2.

Tops of medium size and sugar contents are a little higher than E. strains.

Z. Type.—Marster's British Hilleshog: High sugar content; yield of roots per acre usually below the E. strains.

For early sowing.—Marster's British Hilleshog, Webb's No. 2, *Johnston's Perfection* (*E and N*), *and Klein E*, are suggested.

For very rich soils, where the tops are apt to be very large, smaller topped strains are an advantage. These include *Marster's, Webb's No.* 2, *Johnson's Perfection* (*E and N*).

For early lifting, a strain with a high sugar content is best.

Sowing the Seed.

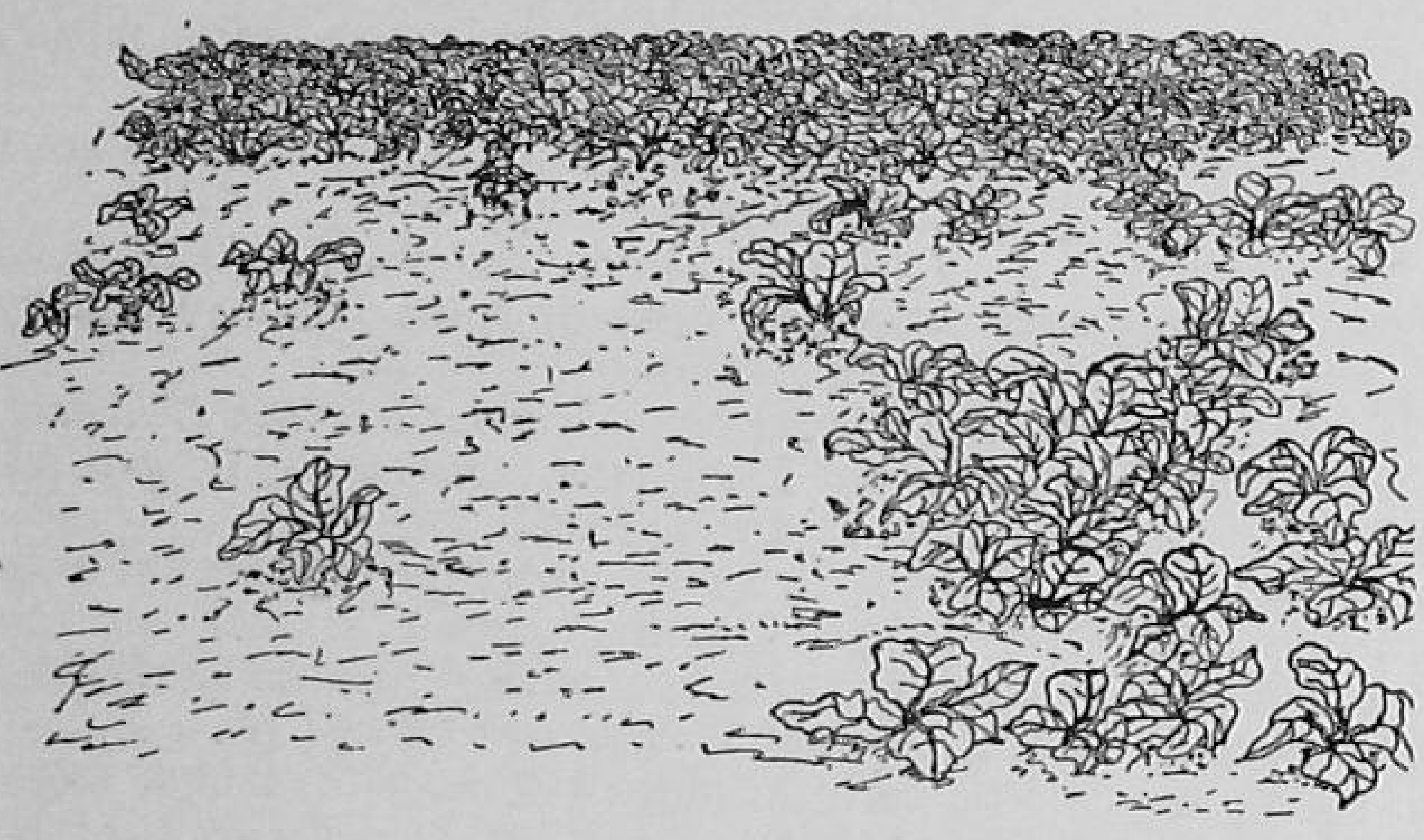
A good seed-bed should be fairly solid underneath and there ought to be a fine tilth at the surface. The seed is usually drilled on the flat. The distance apart of the rows generally varies from 18 in. to 24 in., the narrower width being suited to light land and the wider to good heavy land where the individual beet are likely to grow larger. If there is any appreciable amount of rubbish the rows are best sown fairly wide to permit of more cleaning. It is quite common to roll, drill and then roll again. Some drills have small wheel-rollers behind each coulter; this leaves a mark and enables the crop to be horse-hoed before the seedling plants are above ground. About 15 lb. of seed per acre are usually drilled. It is very important that the rows should be as straight as possible, and a steerage drill is best, if available.

When there has been very little frost and the seed-bed is unkindly, much rolling and harrowing may be necessary before a reasonable seed-bed

can be secured on heavy land. In this connection the Cambridge roll has been found most useful, as has also a north country tool made of pieces of wood fastened together in such a way as to give a "scrubbing" action when drawn over clods. The depth of drilling varies to some extent with the conditions of moisture in the soil. It is better not to drill too deeply, but if the soil is dry the seed must be put in a little deeper in order to reach moisture and if possible ensure germination.

After-Cultivation.

The beet should be horse-hoed as soon as possible. An efficient horse-hoe is very important. Some horse-hoes are fitted with discs to prevent clods and earth covering up the small plants. These enable the coulters to go nearer the rows. Chopping out or bunching should be done as soon as the first four leaves have appeared, singling being done soon after. If, owing to scarcity of labour, it is impossible to get singling done as soon as desirable, chopping out will reduce damage to plants. It has been found that the crop is seriously reduced, if, owing to scarcity of labour or wet weather, chopping out and singling is delayed even by a week.



Wireworms.—A crop of sugar beet attacked by wireworms, showing a large patch with hardly any beet on it. The land had recently been permanent grass.

Rayns states that with 18 in. rows, the aim should be a regular spacing of plants at 10 in. apart in the rows on ordinary land, and on light land at 9 in., and this has been confirmed in Suffolk. Very careful supervision of the work of singling is necessary, especially if inexperienced workers are employed. Careless workers may seriously reduce the yield by chopping out plants which should be left.

It is frequently held that 30,000 plants per acre is the best number, but the writer shares with others the opinion that the ideal number depends upon the character of the land—on rich, or good heavy land where large individual beet may be expected, 24,000 beet may be enough. On the other hand, on poor sandy land, where it is useless to expect large beet, double this number may be necessary to give a really heavy crop. The beet must be horse-hoed and hand-hoed during the summer, care being taken that weeds never have an opportunity to get any appreciable size. Once the beet tops meet in the rows, they shade the weeds, and, to a considerable extent, check their growth.

Lifting

Lifting may commence in late September, owing to the necessity of keeping the factory going over as long a season as possible. As a rule, even with early sown beet, the roots continue to increase in weight much later than this. In the case of late-sown or late varieties of beet, increase of weight may continue until the end of November or even later. Usually lifting continues until the end of December, weather permitting, and very often during the war years the whole of the season's beet was not delivered to the factory until the end of January. Where they have to be stored in heaps beside the road they should be protected from frost. On most types of soil it is usual to use a sugar beet lifter to loosen the roots, after which they are knocked together to shake off as much dirt as possible, topped by hand and put into rows or heaps, being subsequently carted to a convenient place where they can be loaded on to a lorry.

Much attention has of late been devoted to designing a machine which will lift and top the beet efficiently, but such machines have not yet reached a very high state of perfection.

The yield of roots varies from an average of 8 or 9 tons to 20 tons or even more per acre.

Sugar Percentage.

Sugar Percentage varies to a considerable extent with the season. In some cases it may be as low as 15 per cent, in others, individual crops may go up to 22 per cent or even more. The influence of manure is not so great as was at one time thought, but excessive quantities of nitrogen undoubtedly lower the percentage. The soil also has an influence. As previously noted, certain strains have a higher percentage of sugar beet than others.

Sugar beet pulp is a valuable by-product after the sugar has been extracted at the factory. One pound of dried pulp is equivalent in value to 7 to 8 lb. of mangolds as a food for cattle.

Valuable Cattle Food.

Sugar beet tops and crowns are also very valuable cattle food. During the season they are carted off and fed to the animals. It is desirable to add 1 lb. of ground carbonate of lime to each cartload of tops to neutralise the oxalic

BARLEY

Farmer & Stock-breeder Photographs.

Above: CUTTING SEED-PEAS GRANGE FARM, COGGESHALL, ESSEX
Below: SEED-PEAS: NO WASTE WITH THE RICK-CLOTH UNDER THE WAGGON
Farmer & Stock-breeder Photographs.

acid present. According to Woodman, 25 lb. of sugar beet tops are roughly equivalent in feeding value to 40 lb. of mangolds. Great care should be taken to avoid mixing them with soil. They make an excellent fold for sheep—in one case 4 acres of beet tops kept 240 sheep for ten days.

When they cannot all be used in the fresh state sugar beet tops can easily be made into silage, in a clamp, and some farmers preserve large quantities in this way, subsequently feeding to farm animals. When they cannot be utilized in any other way, they are ploughed in as manure; but as their most important constituent is sugar which has no manurial value, this is rather a wasteful procedure.

Insect Pests.

Insect pests and eelworm.—Wireworms may do much harm in thinning out the crops, especially after old pasture. The danger is reduced if the beet are sown rather late in the season, as they then grow rapidly away from the pest. (See Wheat p. 166).

Flea beetles may do much harm in certain seasons (see Swedes and Turnips, page 211). Eel worms may greatly damage the crop where it is grown too frequently on the same land. In this country the farmers' contract with the factory, stipulates that sugar beet must not follow sugar beet, without a suitable interval of years.

MANGOLDS.

Climate and Soil.—For farm animal feeding mangolds are the most important root crop grown in the drier parts of England. They thrive on a wide variety of soils, but like most crops succeed best on a deep medium loam.

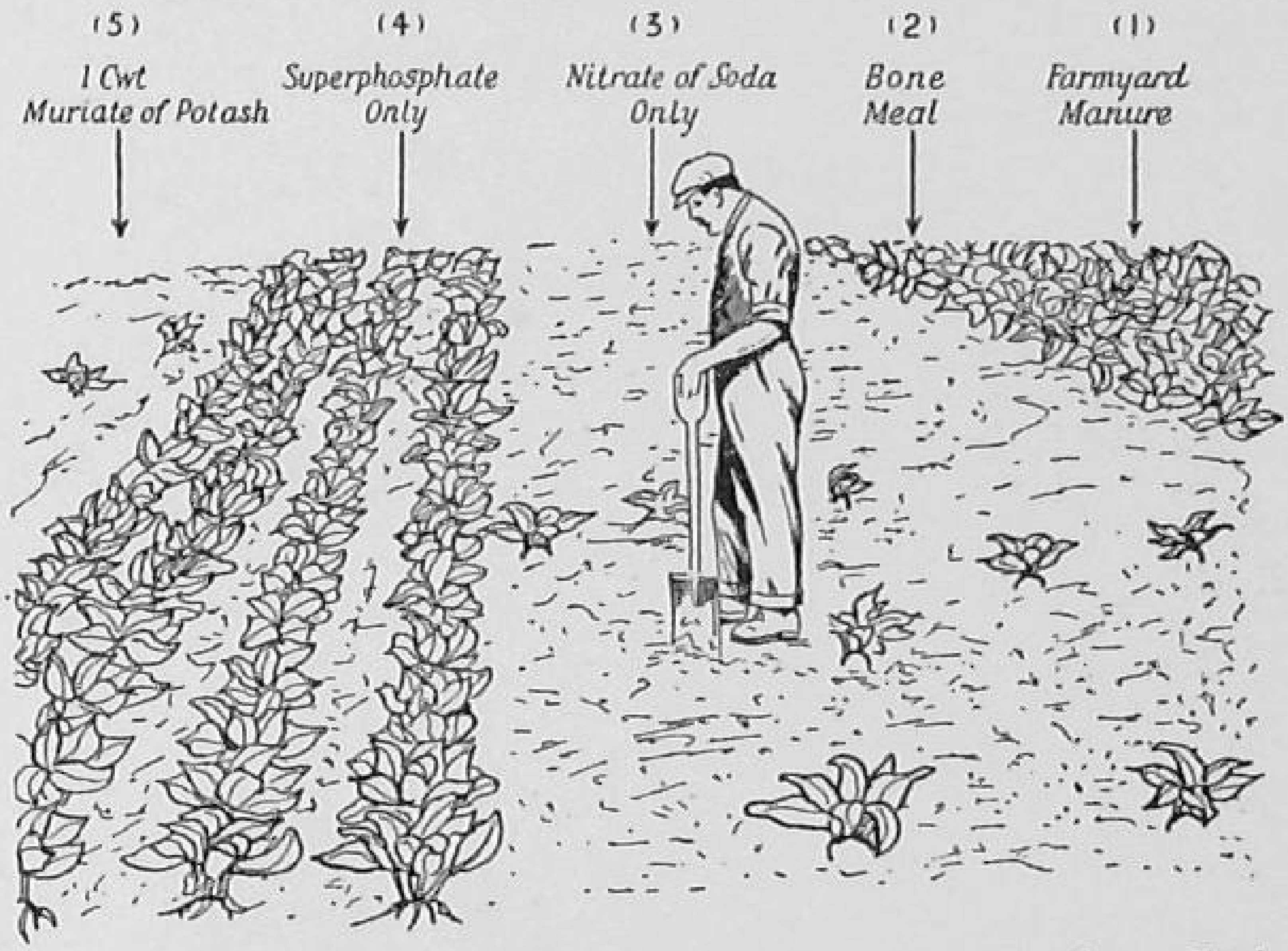
Place in Rotation.—They occupy the same place in rotation as other crops, i.e. usually after a cereal. They may, however, be grown after almost any crop. Cases are on record where they have been grown year after year on the same land with great success, but this is unwise, since it may increase soil pests.

Preparation of Land.

The general principles in the preparation of the land are the same as those outlined for other roots. Mangolds, however, must be drilled earlier than swedes and turnips; hence there is less time to clean the land in spring. As much autumn cleaning as possible should be done and, on heavy land, a final deep ploughing should, whenever possible, be given before the new year. This secures a winter tilth which is of the greatest possible importance in securing " a plant."

In spring, on heavy soils, the land is worked down and it is an excellent plan to horse-hoe or scoop-hoe it before drilling. A cutter bar, attached to a cultivator and set to cut to a depth of 3 inches is also a most useful tool, in that like horse hoe or scoop hoe it keeps the winter mould on the surface. More liberties may be taken with light land and it may be ploughed a short time before drilling. It is possible that most of the mangolds now grown are on the " flat " but in districts of relatively heavy rainfall they are grown on the ridge.

There are a large number of strains of mangolds, with at least four main shapes—globe, tankards, intermediate and long.



Mangolds at Saxmundham Heavy Land Experimental Station. Each plot has received the same manure for 40 years, but has been cropped in rotation:—wheat, mangolds, barley and leguminous crop.

Plot (1) 6 tons Farmyard Manure per acre.
„ (2) 4 cwt. Bone Meal.
„ (3) 2 „ Nitrate of Soda.
„ (4) 2 „ 30% Superphosphate.
„ (5) 1 „ Muriate of Potash.

Note. Fair crops are obtained with Farmyard Manure, and where phosphates are applied either as bone meal or superphosphate. In the absence of Farmyard Manure or phosphates, the crop fails completely.

Varieties.

The yield of dry matter per acre and the keeping quality are the most important points. It has been shown by feeding trials that the food value of mangolds is proportionate to their dry matter, which consists chiefly of sugar.

It is worthy of note that a crop of 25 tons per acre with 14 per cent of dry matter yields 3·5 tons of dry matter per acre, whilst a 30 ton crop with 9 per cent dry matter gives only 2·7 tons and involves the carting home of 5 tons extra water.

The trials conducted by the National Institute of

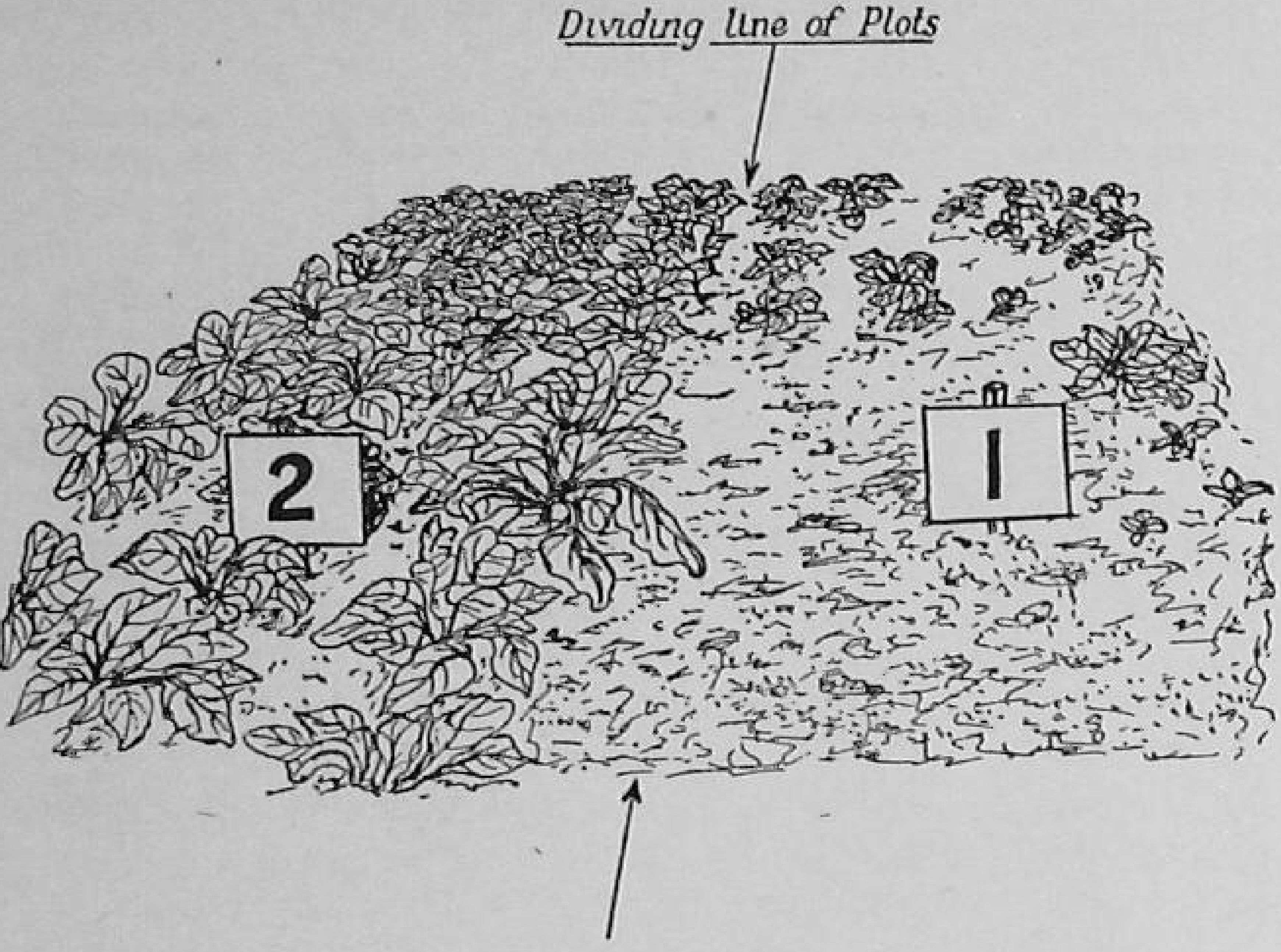
Agricultural Botany have shown that under most conditions "*Kirche's Ideal*" gives the highest yield of dry matter per acre. Long red mangolds may give very high yields of dry matter on deep rich soil.

Manuring and Lime.

Heavy Land.—Farmyard manure should be used, as much as can be spared up to 20 tons per acre, if possible ploughed under in autumn or winter and in addition—

4 cwt. super . . . . 2 cwt. sulphate of ammonia . .	Mixed together and applied before drilling.

One to two cwt. of agricultural salt may also be used, and should be applied a month before drilling. If there is a good plant, 1 cwt. per acre of nitrate of soda or lime or " Nitro-Chalk " may be applied after singling.



Saxmundham Heavy Land Experimental Station.

Mangolds.—Plot (1) No Manure for 40 years.
,, (2) 10 tons per acre Farmyard Manure every 4 years applied to the wheat.

Note the almost complete failure where no manure has been applied. Also that Farmyard Manure applied to the wheat preceding the mangolds has left a residue which has resulted in quite a respectable crop of mangolds.

Lighter Soil.—Farmyard manure should be used up to 20 tons per acre.

Four cwt. agricultural salt or kainit (when available) applied 3 or 4 weeks before drilling.

1 cwt. sulphate of ammonia . . 2 cwt. super	Applied at drilling.

1–2 cwt. nitrate after singling if there is a good plant.

Lime.—Mangolds are very sensitive to lack of lime in the soil. If the soil requires it, a sufficient dressing should, if possible, be applied 18 months before sowing the mangolds (see Liming, page 154).

Sowing.

On the flat the rows are usually 21-24 in. apart, 8 to 10 lb. of seed being sown per acre. When grown on the ridge or baulk the rows may be 28 in. apart. The farmyard manure in a moist district may often be applied in the ridges, being covered when the ridges are closed. In most parts of England it is probably best to sow early in April if the land be clean.

It very often happens in a dry spring that there is difficulty in getting the moisture to the seed, especially if the land is rather cloddy. This means a bad " plant." If the land is rolled down very firmly after drilling, preferably with a rib-roll, the seed is more likely to germinate.

Treatment During Growth.

Treatment is similar to that of other root crops. Horse- and hand-hoeing must be carried out sufficiently often to ensure that weeds are destroyed in their young stages, otherwise the crop is greatly injured. It is impossible to over-estimate the importance of this point. Thus a seedling fat-hen (goose foot) half an inch high has done hardly any harm, but in two months it may have become an immense plant, perhaps 3 feet high, which has damaged the crop over 2 or 3 square yards.

Chopping and singling should take place when the small plants are in the four-leaf stage.

The roots are usually lifted in late October or early November. If the soil is dry at lifting they are apt not to keep well unless they are sprinkled with water on the heap.

It is important to lift and store before severe frost occurs as this causes great damage.

Harvesting.

The roots may be stored in long clamps, covered first with rough grass or straw, and then with earth, or they may be put into larger heaps with plenty of hedge-side grassy material, earth being subsequently put around them. Sometimes it may be possible to make a large heap in a sheltered position against stacks or buildings which need little or no earth covering. Baled straw is also very useful in protecting mangolds, being used as a wall, on either side of a heap, to " contain " the roots.

Yield.

Crops of from 20 to 40 tons per acre are obtained under ordinary farming conditions. Where the crop is limited by a low rainfall it may be difficult to exceed 40 tons per acre, even with really good farming. With ample rainfall however, under really good soil and manurial

conditions, considerably greater yields have been obtained. There can be no doubt that the average crop could be greatly increased—probably by 50 per cent—by taking great care to conserve moisture and to secure a regular plant by singling very carefully, by ensuring the mangolds are not injured by weeds, and by suitable and generous manuring.

Mangolds share with cabbages, kale and a few other green crops the valuable quality that their yield can be forced to a very high level without risk of the crop being spoilt. Corn crops, especially, must not be manured beyond a certain not very high level or the crop becomes laid, and may be seriously damaged.

Insect Pests.

Probably the most serious insect pest is the mangold flea beetle, which in certain years damages the seedling crop in the same way as the flea beetle attacking cruciferous plants. Preventive measures are the same (see Swedes and Turnips, below). Fortunately the crop is rarely injured beyond recovery.

Wireworms, if abundant, sometimes seriously injure mangolds. Where it is known that a field is badly affected, it is best to sow the seeds thickly and not too early, so that in the warmer weather which prevails a little later, the crop may grow away rapidly from the pest. It is also wisest to chop out the plants, but not single them until they are fairly large, when they are less likely to be thinned out by the wireworms. (See Wheat, p. 166).

Utilization.

Mangolds are an important source of carbohydrate food for live stock from about the beginning of January until May or even June. Before the new year they are unripe, and not suitable for use. They are especially valuable for cows which maybe receive up to 60 lb. daily. They are also suitable for all classes of cattle, for sheep and, in small quantities daily, for horses and pigs.

Swedes and Turnips.

Swedes and Turnips are the most important root crops in the more northerly parts of England and in most parts of Scotland and Ireland. Considerable areas of white turnips are grown in southern districts—partly for folding by sheep.

Both Swedes and turnips thrive in a moist and rather cool summer. In very dry weather they suffer from mildew and this may ruin the crop.

Climate and Soil.

Those who have seen a crop of swedes on good land under northern conditions—crops which may reach 50 tons per acre—realize how disappointing it is to grow swedes under the conditions prevailing in southern England, where perhaps only 10 tons per acre may be obtained.

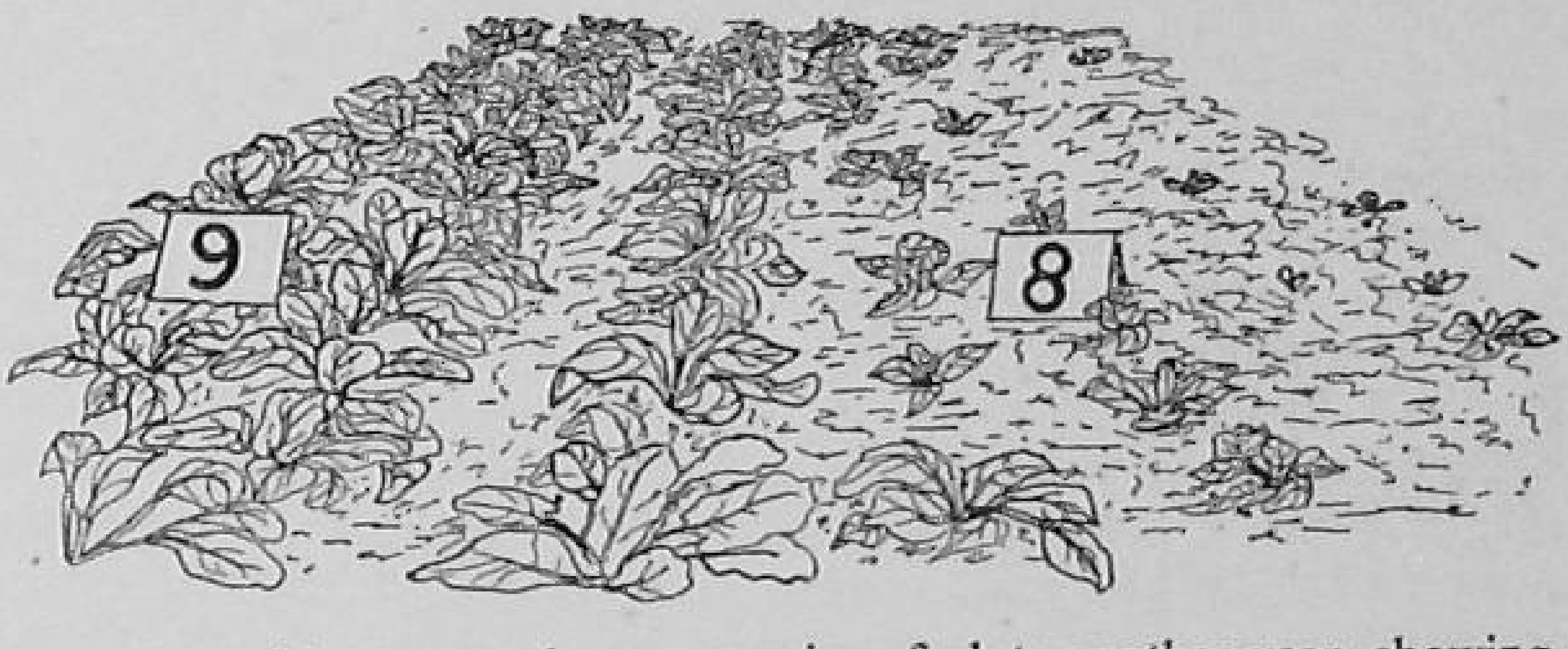
Swedes have of late, however, been much used as a table vegetable, and where they are wanted for this purpose they must of course be grown locally whatever the climate. They are too watery to cart very far.

Swedes and turnips thrive best on light loams containing a sufficient quantity of lime.

Preparing the Land.

The land is prepared, as already been described for roots at the beginning of the last section. In southern districts where swedes may not be sown until mid-June, there is more time for this than where mangolds or sugar beet are to be grown. White turnips are often grown in the south after another crop such as Trifolium (or any crop removed by the end of July). In all cases it is important to kill the weeds as far as possible and to get a good tilth before drilling the seed.

Swedes and turnips are usually grown on the "ridge," "drill," or "baulk" in the north, and on the "flat" in the south.



The Mangold crop on the same series of plots another year, showing

Plot (8)	2 cwt. Nitrate of Soda	}	Failure owing to lack of Phosphates.
	1 ,, Muriate of Potash		
,, (9)	2 ,, Nitrate of Soda	}	Quite a good crop.
	2 ,, Superphosphates		

Farmyard manure which should be used if possible is usually put in the ridges which are then closed upon it when that system of growing the crop is adopted. Where the roots are grown on the "flat" the manure may be ploughed in during the winter or it may be applied after thoroughly cleaning the land in spring and ploughed in at the last ploughing.

Varieties.

Swedes, which have a distinct neck, have firmer, sweeter and more nutritious flesh than turnips. The dry matter varies from 10 to 12½ per cent. The heavy weight obtainable per acre under favourable conditions, however, means that much dry matter is obtained per acre. Thus a 30-ton crop of swedes contain 3 tons or more of highly digestible dry food per acre, which compares favourably with most crops. Swedes have skins of different colours: purple, green or bronze.

Purple top swedes are of two groups:—

(1) Pale Purple Top.—These are heavy yielders which mature early and are suited to mild districts. Of these Tipperary and Majestic may be mentioned.

(2) Those with rather darker skin are hardy but not such rapid growers, though better keepers than the Pale groups. Good strains are: Best of All and Purple King.

Bronze Top swedes are more hardy than Purple Tops.

Green Top swedes are rather slow in growth, have a high dry matter content, are very hardy and keep well for late feeding. The Danish variety, Wilhelmsburger, deserves special mention for its high dry matter, its exceptional hardiness and good keeping qualities. It is also highly resistant to finger-and-toe—one of the worst diseases which attack swedes and turnips.

Yellow-Fleshed turnips are to a considerable extent intermediate in character between swedes and white-fleshed turnips and contain 8 to 10 per cent dry matter. In Scotland May sowings give better crops than later sowings. Aberdeen Green Top and Purple Top strains are worthy of mention, as is also the " Bruce," which has a high resistance to finger-and-toe; it has purple skin and the roots keep well.

White-Fleshed turnips contain 7 to 8 per cent of dry matter. They grow very rapidly and may be sown in England as late as July or August, often being grown as a catch crop. When drilled late they will grow to a considerable extent during a mild winter and in spring their tops may be saleable as a green vegetable for human consumption.

Manuring and Lime.

The manuring of swedes and turnips differs to some extent in various parts of the country. In the north of England, Scotland and Ireland it is reasonable to expect a heavy yield on good soils, and the crop, especially swedes, is manured generously with both farmyard manure and artificials. In these districts only a very small area of white turnips is usually grown, the latter crop being more popular in southern Britain, where it is often merely a catch crop and where really heavy yields are not expected and probably, owing to climatic conditions, not obtainable in an ordinary season. On most soils, phosphates are the most important plant food, but this may not apply to very light soil, especially in a dry climate.

In Ireland, in an average of many experiments, 4 cwt. of 30 per cent super per acre increased the crop from 4 tons 9 cwt. with no manure, to 20 ton 7 cwt. with the super—truly remarkable testimony to the value of phosphates. Five to six cwt. per acre high quality basic slag per acre has been found satisfactory as a source of phosphates, especially where the soil is poor in lime. The roots do not grow so rapidly as with superphosphate; they are, however, apparently of slightly higher feeding value.

Basic slag also tends to discourage finger-and-toe disease. The following manuring is suggested for average conditions:—

Swedes and Turnips:—

10 tons farmyard manure and 4 to 5 cwt. 30 per cent super, or 5 to 6 cwt. basic slag. If the land is poor, then nitrogen and potash may be added, say:—

½ to 1 cwt. sulphate of ammonia or nitrate of soda, and 1 cwt. Potash Salts (40%) (especially on lighter soil).

When farmyard manure is not available the quantity of artificials may be as follows:—

5 cwt. 30 per cent super (less on light land)	Applied before sowing the seed.
1–2 cwt. sulphate of ammonia or nitrate of soda or nitrate of lime or " Nitro-Chalk," and	
1–2 cwt. Potash Salts (40%) (especially lighter soils) ..	

Six cwt. basic slag may be used instead of the super, but it must not be mixed with sulphate of ammonia.

In northern and western districts where a heavy crop may be expected, manuring is more generous than in the south.

Swedes and turnips are sensitive to lack of lime in the soil, and often suffer from finger-and-toe under these conditions. White turnips may, however, grow fair crops on rather acid soils. It is most important to rectify any lack of lime as it is really not worth while trying to grow crops on such land. The soil should be tested by the advisory chemist, and whatever quantity, if any, he suggests of the cheapest form of lime obtainable locally should be applied.

Swedes may be drilled in May or June—the earlier date being more common in those districts where a good crop is expected. White turnips are usually put in during June, July or even as late as August.

Sowing the Seed.

Where farmyard manure has been applied in the baulks, drills or ridges, a special root drill, taking one or more rows, which has a roller fitting the ridges is used. The width of the ridges differs according to the cleanliness of the land, 24 in. to 27 in. being an average.

Where the roots are grown on the flat the cup drill is used, as with mangolds or sugar beet the width of the rows varies from 18 in. to 24 in., the narrower width in the case of turnips growing as a catch crop.

The quantity of seed used varies. If no attacks of insect pests ever occurred, only a very small quantity would be necessary, but 4 lb. is probably

an average quantity. Occasionally late sown white turnips are sown broadcast very thinly, say 1 lb. of seed per acre.

Singling.

The crops are singled when they reach the rough leaf stage. The distance they are left apart depends to some extent on the date of sowing, the width of rows and whether really large roots can be expected. The 7 in. hoe is a very good tool to use for the purpose. The plants actually average 9 in. to 10 in. apart in the case of swedes. Late sown white turnips are left closer than this, and may even be cross-harrowed and not singled at all.

When white turnips are sown broadcast they are not singled.

Treatment During Growth.

The crop is horse- or tractor-hoed as soon as this can be done without injury to the seedlings; where the crop is grown on ridges or drills, this is possible before the young plants appear. It is subsequently horse-hoed once, twice, or three times and hand-hoed perhaps once or twice more after singling according to the number of weeds present. Swedes being sown earlier require more hoeing than turnips.

Swedes and turnips like all root crops are "fallow" crops and one important object in growing them is to clean the land of weeds without leaving it unplanted for a whole year. For this purpose swedes, and especially turnips, are better than mangolds since they can be sown later. Hence it is very important that all necessary cultivations should be given both before and after drilling the crop and that no weeds should be allowed to make appreciable growth.

Lifting and Storing.

The swede crop is mature when the lower leaves begin to wither, the date depending upon when the crop was sown. Swedes are usually stored in long clamps or in heaps covered with straw or grass. Swedes are less liable to damage by frost than mangolds, but it is best to lift them in late autumn partly in order to avoid poaching the land to an unnecessary extent and also to give time to get it ploughed under favourable conditions and in order to get the winter frosts.

When late-sown swedes or turnips are to be folded by sheep, they may not be lifted at all, but eaten as they grow. Sometimes the crop is made into small heaps in the field in which it grows with a thin covering of straw and soil, the roots being subsequently fed to sheep.

Utilization.

Swedes are most valuable for feeding store stock and for fattening cattle, being especially valuable for the carbohydrates they contain, these being in a highly digestible form. In those districts of Scotland which are devoted to fattening cattle they are fed in large quantities, sometimes 1 cwt. per animal per day being given. For milking cows they must be fed in smaller quantities, as they are apt to impart a slight flavour in the milk. Swedes are also a very valuable food for sheep. Turnips are fed to both cattle and sheep, the latter being often folded upon them. The roots are very often thrown upon the pastures to be eaten by either cattle or sheep. Turnips contain much less dry matter than swedes and hence are of lower feeding value. The high proportion of water in mangolds and in swedes—about 88 per cent—and in turnips—about 92 per cent—is apt to lead to the conclusion that they are of little value as food. This, however, is quite wrong. The water in them serves as drink to the animal, and the dry matter present is in a very digestible form.

They must be regarded as very satisfactory foods, provided excessive quantities are not fed. A cow receiving 60 lb. of mangolds daily (a suitable quantity) will receive more than 7 lb. of very digestible dry matter in them; this will make a notable addition to the cow's ration.

Yield.

Average Yield.—In the cooler districts of the British Isles, yields of 20 to 30 tons are common, and much heavier crops than this are occasionally obtained. In the warmer and drier parts of these Islands 10 to 15 tons are commoner yields.

Insect Pests.

The turnip flea-beetle, known amongst farmers as the "turnip fly," or "Jack," which attacks all cruciferous plants (swedes, cabbages, kale, etc.) is by far the most serious insect pest. It eats the leaves of the seedling and very frequently destroys the plants altogether, thus necessitating a second, or even a third, sowing. This insect is somewhat bigger than a pin head, and when disturbed jumps away suddenly, hence its name. It can be readily seen on the seedling plants by the cautious observer. The most damage occurs in hot dry weather.

Modern "Flea Beetle dusts" are very effective in protecting crops from attack. It is important that the dust should be applied immediately an attack is noticed hence it is wise to have a stock of "Flea Beetle dust" on the farm in readiness. The work can also be done by contractors who use dusting machines mounted on row-crop tractors, the dust being applied under a dust sheet.

When the plants are being attacked they may sometimes be saved by sowing dusty substances such as basic slag or lime upon them when the dew is still on the plant.

Dragging a pole, to which a number of bags soaked in paraffin have been attached, across the field, has been carried out with success. Even unsoaked bags dragged across the field have done

good by making a dust which adheres to the leaves.

Fungous Pests.—The most serious pest to which plants of the cruciferous family are subject is finger-and-toe, club root or anbury; these being different names for the same trouble. The roots are attacked by a fungus which causes them to become clubbed, misshapen, and in many cases to rot, leaving the plant almost without roots.

This very serious disease occurs on acid soils (i.e. lacking lime) and may be eradicated by applying a sufficient dose of that substance to the soil, and then allowing two or three years to elapse before a cruciferous crop is planted on the land again. In gardens and in other places where cruciferous plants are grown very frequently it is especially liable to occur.

Cabbages and Kale (Brassicas).

A number of allied plants including cabbages, kale and the brassicas of the market gardener (Brussels sprouts, cauliflowers and greens generally) all belonging to the cruciferous family, may be conveniently considered together, since their cultivation is in many respects similar.

The land is prepared as for roots, being cleaned as far as possible before the crop is put in.

Climate and Soil.

These crops are grown in all parts of the British Isles, but are especially favoured by farmers in dry districts where swedes are not usually a success. They appreciate good soil rich in nitrogen and are very suitable to grow as a first crop on rich broken-up grassland. They are all usually grown in the root shift, but may be grown after any plant which does not belong to the cruciferous family. In order to avoid finger-and-toe disease it is best not to grow them after another crucifer.

Varieties.

Cabbages.—There are many varieties but for the farmer the Drumhead is perhaps the heaviest cropper.

Of *Kales* we have Marrow Stem, both the stems and foliage of which are eaten.

Thousand-head, which produces much foliage.

Hungry Gap Kale, which is ready for use in April, when there is often a hungry gap (i.e. a scarcity of green food). The young shoots picked in early spring are often used as " greens " for human consumption. Hungry gap kale shoots are extremely palatable.

All these cabbage-like plants appreciate generous manuring and if suitably treated may give enormous crops.

Manure.

Manures per acre.—Farmyard manure is used up to 20 tons per acre. In dry districts this should if possible be ploughed in during the winter, especially on heavy land, and in addition—

3–4 cwt. super .. .. .. 1–2 cwt. Potash Salts (40%) (on light land only); 2 cwt. sulphate of ammonia	Mixed together and applied before planting.

1 to 2 cwt. of nitrate applied later.

Even larger quantities, up to 6 cwt. of nitrogenous manure have been applied, with good results to kale.

All these plants require a sufficient supply of lime in the soil, otherwise they are liable to suffer from " finger-and-toe " (see Swedes and Turnips, page 211), and also to make unsatisfactory growth.

Sowing the Seed.

Cabbages are often sown in a seed bed, and then transplanted into the field—1 lb. of seed providing enough plants for an acre. In dry districts, however, they are often drilled where they are to remain, at the rate of 3-6 lb. per acre—if possible in March.

Marrow stem and Thousand head kales may be drilled in March, April, May or even June, at the rate of 3-6 lb. per acre.

Treatment During Growth.

When cabbages are drilled where they are to remain, they must be thinned to a distance varying with the type of cabbage. Drumhead cabbages are often grown in 27 in. rows and about 2 feet apart from plant to plant. Smaller cabbages are grown in rather narrower rows and are left closer together.

Kale is usually roughly chopped out, but quite frequently of late it has been drilled rather thinly and left unthinned. Horse-hoeing is performed as often as is necessary to keep the weeds from doing any harm.

Utilization.

The crop of cabbages or kale is either carted home and fed to cattle, or folded. They form a very valuable winter feed, being richer in protein than the " root " crops. It is probable also that the fact that they are *green* succulent food gives them an especially high food value for winter use.

Average Yield.

Immense crops; 30-40 tons per acre of both cabbages and kale may be grown with very intensive farming. Often, however, quite small crops are obtained—10 to 15 tons per acre. Very heavy crops of kale have a good effect in smothering weeds.

Insect and Fungous Pests.

Like all cruciferous plants, seedling cabbages and kale are attacked by the turnip flea-beetle.

this, in spite of the precautions outlined under "Swedes and Turnips," page 211, is a very serious pest, and many cases are on record of fields having to be sown two or three times (and even then of failing to obtain a plant).

Mr. S. O. Ratcliffe has found that Brassica plants generally may be protected from attack by flea-beetle by intercropping with peas. The flea-beetles will not work in the shade afforded by the peas.

(See "Peas," page 180. Also *Journal of the Ministry of Agriculture*, March 1943.)

"*Finger-and-Toe*" is a very serious pest with cabbages on land suffering from lack of lime. (See "Swedes and Turnips," page 211).

Kohl Rabi.

Kohl rabi belongs to the cruciferous order of plants and the part used for feeding is really a swollen stem. It is grown in the drier parts of England where swedes do not thrive and, when generously treated, will grow a considerable weight of valuable cattle food per acre. In East Anglia it succeeds well on mixed soil, i.e. soil neither heavy nor light. The land is prepared as for roots and the seed is drilled if possible at the end of March or early in April, at the rate of about 4 lb. per acre.

Manuring.

Farmyard manure, 10-15 tons per acre ploughed in during the autumn or winter, also—

3 cwt. super .. .. .. } Applied before sowing the crop.
1 cwt. Potash Salts (40%) .. }
1 cwt. sulphate of ammonia .. }
1 cwt. nitrate of soda after thinning.

Utilization.

All farm animals thrive upon Kohl rabi which, being fit for use in early autumn, are often not stored, but used at once. They are very suitable for folding with sheep and as food for cows. A well-known farmer of mixed soil in a dry district observed, "I find that an acre of Kohl rabi will feed my cows longer than any other kind of root."

Rape.

Rape, colewort or cole seed is a very useful plant for sheep feed and is largely grown for that purpose, especially in Wales. It is a rapid growing plant and may be sown in spring or summer. It is also sown mixed with turnips (3-4 lb. rape seed and 1-2 lb. hardy green turnip seed per acre) for autumn or winter feed, or with lupins for August, September or October use. It has been found useful as a "pioneer" or first crop to sow on inferior and often high-lying land ploughed up. Very often the herbage on such land consists merely of inferior vegetation—bracken, bent-grass, etc., and the prospects for the first crop are doubtful. The vegetation is buried deeply and the land is limed, slagged and rape sown. A crop of this kind does not involve so much labour or cost, as most other crops; hence a failure is not such a disaster. The herbage is eaten by sheep, and this both manures and solidifies the land and helps the mass of roots and vegetable matter to decay. In consequence of such treatment, the next crop is much more likely to be a success.

Soil.

Rape grows very heavy crops on fen soils rich in humus. It will, however, thrive on most soils provided they contain sufficient lime and are generously manured. If there is not sufficient lime in the soil it will completely fail. Rape is frequently grown as a catch crop, after such crops as Trifolium, tares or rye, folded with sheep in spring. It has also been sown successfully at the rate of 6 lb. of rape seed and 1 lb. of turnip seed per acre in growing beans at the time of the last horse-hoeing, and very useful feed has been provided in this way for October and November. A famous Suffolk flock-master sowed a little rape mixed with rye grass and Trifolium in August, with the object of providing sheep feed in April. It has also been sown, especially in Wales, in admixture with grass and clover seeds when inferior grassland has been ploughed up and re-seeded directly. In this case only a small quantity, 2-3 lb. per acre, is sown and the whole is grazed with sheep when the land is fairly dry. Such a crop is not usually folded in small enclosures but the sheep are run over several acres at a time.

Manuring.

Very frequently rape is seriously under-manured. When generously manured with farmyard manure or artificials—nitrogen, phosphates and potash, it will grow a heavy crop of very valuable sheep feed, and after feeding this the land is enriched by the sheep manure and is in a better form to grow a corn crop. It thus takes the place of turnips which are more expensive to grow.

The green plant contains 14 per cent of dry matter, as compared with 11½ per cent in the case of swedes. Rape has an excellent reputation amongst shepherds—in fact, it is regarded as one of the best sheep crops available.

ROOT CROPS AND CROPS RECEIVING SIMILAR TREATMENT—*concluded*

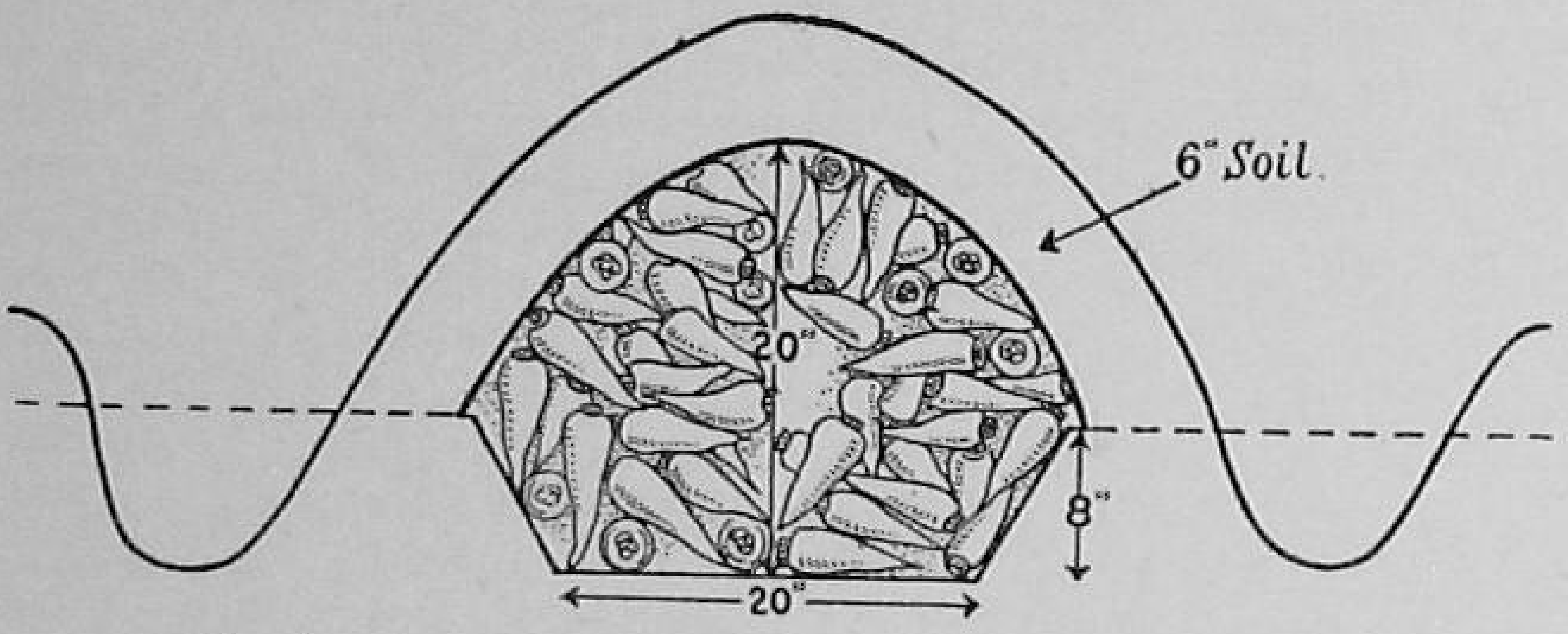
The crops remaining for consideration are Carrots and Mustard; with each of these our author here deals, treating of the best soils for the crops and of the methods of growing and using them.

Carrots.

In certain districts of light land in England carrots are grown as a field crop. They thrive best on light loam, containing sufficient lime, and on such soils may sometimes grow very heavy crops. They usually occupy the root shift in the rotation, but may follow almost any crop. The land is prepared as for other roots, deep ploughing being essential.

Varieties are: (1) Stump rooted; (2) Intermediate; (3) Long rooted.

Relatively little experimental work has been carried out on carrots.



Section of a clamp of carrots, made in light sandy soil.

Manuring and Lime.

At Tunstall, however, under the auspices of Rothamsted Experimental Station, it has been found that they respond well to farmyard manure, fairly well to nitrogen, and very strikingly to potash. The following manuring is suggested for useful light loam:—

10 tons farmyard manure, preferably applied to the previous crop.
2 cwt. super 30 per cent.
1-2 cwt. sulphate of ammonia.
2 cwt. muriate of potash.

On poor land more manure may be given. On good land very heavy manuring is not desirable.

Carrots are very sensitive to any lime deficiency in the soil, and it is probable that many failures have in the past been due to this cause. At Tunstall, where a sufficient dressing of chalk was applied, 33 tons per acre of carrots were obtained whereas the " no chalk " plots gave no crop at all.

Sowing.

A very good time to sow is during the last fortnight in April or first week in May. On a large scale carrots are drilled with the ordinary cup drill. Smaller areas may be drilled with single-row drills or the seed may be mixed with dry sand and sown by hand, in rows.

Distance apart.—The rows may be about 14 to 16 in. apart. Owing to the ravages of the carrot fly it is best to sow the seed rather thinly in order to avoid the necessity of singling which gives the carrot fly access to the roots.

Treatment During Growth.

It is very important to keep carrots free from weeds as they are easily smothered. They are best side-hoed and then horse-hoed as many times as is necessary to keep the weeds down.

If singling is necessary it should be done when the leaves are 2 in. high.

Harvesting.

Carrots drilled at the end of April will probably be fit to lift at the end of October. If difficulty is found in lifting by hand, a sugar beet lifter may be used. In mild districts carrots are sometimes left in the ground all winter. This may result in the loss of the entire crop in a season of severe frost, but growers sometimes take this risk, as carrots look fresher when recently lifted.

Clamping.

Ample protection from frost must be given in the clamp.

At the same time care must be taken that opportunity is provided for the heat to escape or they may rot—especially in a mild winter. If the weather is mild it is best not to earth up the clamp until December. In the carrot-growing district of north Nottinghamshire the plan is adopted of making narrow clamps across the field, partly below the surface of the ground. A cross section of one of these clamps is illustrated above.

This plan can only be adopted in sandy soil.

Mustard.

There are two kinds of mustard. White-seeded, grown for green manuring and sheep feed, and Black-seeded, grown for making ordinary table mustard.

Soils.

Suitable Soils.—Mustard will grow on most soils provided they contain sufficient lime. It thrives especially on those containing plenty of rich vegetable matter.

For Seed.—A firm seed bed is necessary and the seed is drilled in April at the rate of 12 lb. per acre. When the seed pods are slightly green the crop may be cut by hand and tied up into small sheaves. Alternatively, if the crop is not very heavy, it may be cut by the binder or side-delivery reaper.

For Sheep feed the seed of white mustard is sown at the rate of 20 lb. per acre. Growth is rapid and the crop may be fit for folding in 6 to 8 weeks. The feeding value is not very high, but the crop sometimes proves useful.

Green Manuring.—Mustard is one of the best crops for this purpose. (1) It supplies humus to the soil; (2) It prevents soluble plant food being washed out; (3) When ploughed under it appears to check wireworm; (4) If sown on fallows in July it covers the ground in August and so renders less likely an attack of wheat bulb fly on the wheat following. This fly lays its eggs on bare ground.

When ploughing green mustard in, a chain or other contrivance attached to the plough to draw it under the furrow is very useful.

Recently the disposal of surplus straw has become a problem, and, as a means of dealing with it, mustard has been sown, a dressing of nitrogenous manure applied and the loose straw scattered on to the land, the whole being ploughed in after the mustard has made good growth.

MISCELLANEOUS CROPS

In a final chapter Mr. Oldershaw deals with the growing of the Flax-plant and Buckwheat. He points out that the former is grown either for its seed—called Linseed—or for its fibre, Flax. The necessary climatic and soil conditions are indicated as well as the place in rotation. After discussing the preparation of the land for the crop, there is a consideration of the somewhat uncertain topic of Manuring. Observations are made upon Seed and Sowing, and upon Harvesting both for fibre and for seed. Utilization of Linseed is dealt with and there is a note dealing with the leather-jacket, an insect pest that is sometimes serious. The final section of the section deals with the growing of Buckwheat or Brank.

FLAX AND LINSEED.

THE flax plant is grown for two distinct purposes —for fibre and for the seed.

Climate and Soil.

Flax has been grown extensively for fibre for a long period in northern Ireland, and the fairly moist and cool summer there prevalent is probably more suitable than the warmer and drier conditions of eastern and southern England. The severe droughts which occur so frequently in spring in these parts of England naturally tend to make the fibre too short.

For seed production moderately dry conditions may not be detrimental on fairly heavy soil, provided the crop gets a good start in spring. Medium to heavy soil is suitable for the flax plant. Sandy soil does not hold sufficient moisture.

Place in Rotation.

For fibre, flax is often grown after a cereal; it may also be grown after a ley, or as a first crop after grass. Very rich conditions are not good, as they are apt to cause lodging and inferior fibre.

For seed, the crop has been found to be very suitable to grow after old grass, as it is little liable to suffer from wireworm, although it may be attacked by leather jackets. Flax is a suitable crop in which to sow clover and grass seeds or lucerne.

Preparing the Land.—Great care should be taken to obtain a fine tilth, with the soil firm underneath and as free as possible from weeds. On broken-up grassland, especially, the soil should be thoroughly consolidated.

Varieties.—For fibre, *Liral Prince* and *Liral Monarch* are recommended, whilst for seed production, *Royal* is claimed to be best, but *Redwing* and *Diadem* are suitable. "Plate," really a mixture of varieties, has been widely grown for seed in the past, but is inferior to those mentioned above.

Manuring.—For fibre, experimental work in northern Ireland has indicated that under the conditions there prevailing, potash alone, at the rate of about 1¼ cwt. of muriate of potash, gave the best results.

Manuring.

In view of the importance of fibre in the second great war, experiments have been conducted at a number of centres in Great Britain. On old arable land, nitrogen generally increased the crop and the scutched fibre, on the average of all experiments in 1942. Phosphates had a negligible effect.

Potash gave outstanding responses at one centre only out of 18 in two years. The infrequency of responses of scutched fibre to normal fertilizer dressings, shows that the whole basis of the manuring of flax has still to be worked out for current British conditions of growing and processing flax.

Manuring for Seed.—Experiments conducted by the writer led to the conclusion that a complete manure containing nitrogen, phosphate and potash, gave a good return in an increased crop of seed.

For fibre, 90-112 lb. of seed per acre should be used; for seed 80 lb. has often been recommended but even as little as 40 lb. has in some cases given good results with drills 8 in. apart. Less seed is required when drilled than when broadcast.

Seed and Sowing.

In northern Ireland the seed is often broadcast. Drilling with a cup drill at a distance apart in the rows of 8 in. to 9 in. renders horse-hoeing possible, which is a very great advantage, as weeds, especially thistles, are most harmful in flax for fibre. The depth of drilling for fibre should be ½ to 1 inch. The date of sowing varies from March in southern England to April or even early May in the north.

For seed, the crop may be drilled as late as May, even in the dry eastern counties, and owing to this possibility of late sowing it sometimes comes in very useful as a crop that can be put in when it is thought to be too late even for barley. Late sowing for seed may be a success in certain seasons when showers fall and provide sufficient moisture for growth, but when little or no rain falls in May and June, it may be a complete failure. If weeds are present in large quantities the crop may be sprayed with phenoxylene.

Harvesting.

For fibre the crop is pulled by hand or machine. The best time is when the lower part of the stem has changed from green to yellow, and the leaves on this portion have withered and fallen, and when the seeds in the older capsules are just changing from green to a brownish tinge at the apex.

In northern Ireland the crop, after pulling, is

put into ponds or ditches to steep until the fibre will separate, after which it is dried and sent to the scutch mill where the useless part is knocked off, leaving the fibre. Five cwt. or so of scutched flax fibre may be obtained per acre.

In the second great war British farmers were asked to grow flax on contract, in which case the crop after pulling was dried in stooks in the same way as corn. After this it was either stacked or removed direct to the factory, the yield of the whole crop being 2 to 2½ tons per acre. The yield of cleaned and dried seed might be 2 cwt. per acre. In the case of a contract the farmer does not have to undertake the troublesome business of steeping or " retting."

Harvesting for Seed.—The crop is cut when the earliest bolls or seed-vessels are ripe. It is usually cut by the binder and tied into small sheaves and shocked like corn. It may be stacked when dry.

Threshing is done with the ordinary drum, with a concave set very close. Yields of 10 cwt. per acre or a little more are usual.

Utilization.—Linseed is very rich in oil, fairly rich in protein, and has a very high starch equivalent.

In a mixture with other foods it is extremely valuable for calves, fattening and dairy cattle. Thus a mixture of 1 lb. of linseed, 1 lb. beans and 1½ lb. oats contain enough starch and protein equivalent for the production of 1 gallon of milk.

Insect Pests.

Leather jackets occasionally attack the crop. Should they make their appearance the prompt application of 1 lb. Paris Green mixed with 25 lb. moistened bran per acre, will usually give a good control. The Paris Green is very poisonous and has to be handled with great care.

Flea beetles sometimes ruin the crop in the seedling stage but may be controlled by dusting with flea beetle dust—containing either D.D.T. or benzene hexachloride. (See turnips and and swedes).

Buckwheat or Brank.

A small area of buckwheat is grown in the fens and East Anglia. It is one of a small group of plants specially suited for light land and may be grown for grain or forage. The seeds are dark in colour and triangular in section. Buckwheat grows rapidly and if sown in May will probably be ripe by mid-September. If sown too early it may suffer from frost. The seed is drilled at the rate of 1-2 bushels per acre. For sheep folding a mixture of 1 bushel lupins, plus ½ bushel buckwheat was found by the writer to be excellent. For feeding green to cows, 1 bushel buckwheat, 1 bushel peas plus 4 lb. rape has been sown at the end of May for use in August by Mr. J. C. Brown, at the Harper Adams College. The difficulty about growing buckwheat for seed is the harvesting. It is often not ripe until mid-September and the stems are succulent and difficult to dry. It should be cut when the majority of seeds are formed and before the earliest are shed. Owing to the succulence of the stems it may be difficult to get the sheaves dry if the crop is tied. The yield of grain varies from less than 10 cwt. to as much as 1 ton per acre.

SECTION IV

GOOD FARMING BY MACHINE

by

H. J. HINE
B.Sc.(Oxon.)

Illustrations by

ERNEST NICHOLLS

INTRODUCTORY NOTE

We want you to have a clear picture of the kind of machines at present available to the farmer, and to point to the way those machines can best be used to lighten the work and increase the efficiency of the farm operations described in other parts of this practical guide to modern farming.

Early farm machines and appliances were very simple applications of levers and friction. Spades and mattocks were used to stir and pulverize the soil and flint knives harvested the ripe corn or grasses. Corn was ground to flour between stones. Stone axes were used to fell trees to make clearings for new farm adventures, and to make fences to impound the cattle. Grasses and hair were plaited into halters and into traces for draught animals. Little by little, new designs for machines, and knowledge of new materials to make them of, spread over the world; and farm operations came to depend more and more on man's inventiveness and less and less on his muscle.

HAND TOOLS

Hand tools are the simplest farm machines, but the simpler they are the more skill is needed in their use. The craftsmanship of the farm worker reaches its height in the thatching of a rick or the laying of a hedge. In thatching he uses no tools but a jack-knife with which to fashion the wooden pegs; and in laying a hedge he rarely wants anything but a billhook and a stone to keep it sharp.

Digging.

EVEN digging, by spade or fork, hard work as it is—and always must be—can be made easier by skill in knowing just where to grasp the handles, where to apply the foot pressure, and how to achieve that rhythm of movement which eases manual work of all kinds. Little of that skill can be taught, or described, by the written word; most of it comes from practice and from watching those who have already acquired the art of economy of effort.

Spades.

Garden spades have blades with only a very shallow concave curvature. Some ditching spades, used for drainage work, are more curved, and they are made in many shapes. Some have blades that are almost triangular, others have long, narrow, parallel-sided blades.

Good spades are made of fine steels which attain and keep a sharp cutting edge, and which polish to a surface that provides no lodgment for soil to sling and cause friction.

Forks.

Digging forks are usually four-pronged. The prongs themselves are straight, but there is a curve in the attachment of the cross bar to the handle socket. Some forks for farm-yard manure have curved prongs. They are sometimes called drags. Forks that are used for roots often have each prong ending in a knob instead of in a point, so that the roots shall not be damaged. A fork of this kind is better than a shovel for picking up and carrying roots. It is easier to plunge into the heap of roots, and also its use helps to clean the roots, because some of the disturbed small lumps of soil fall between the prongs on to the ground instead of being taken over with the roots.

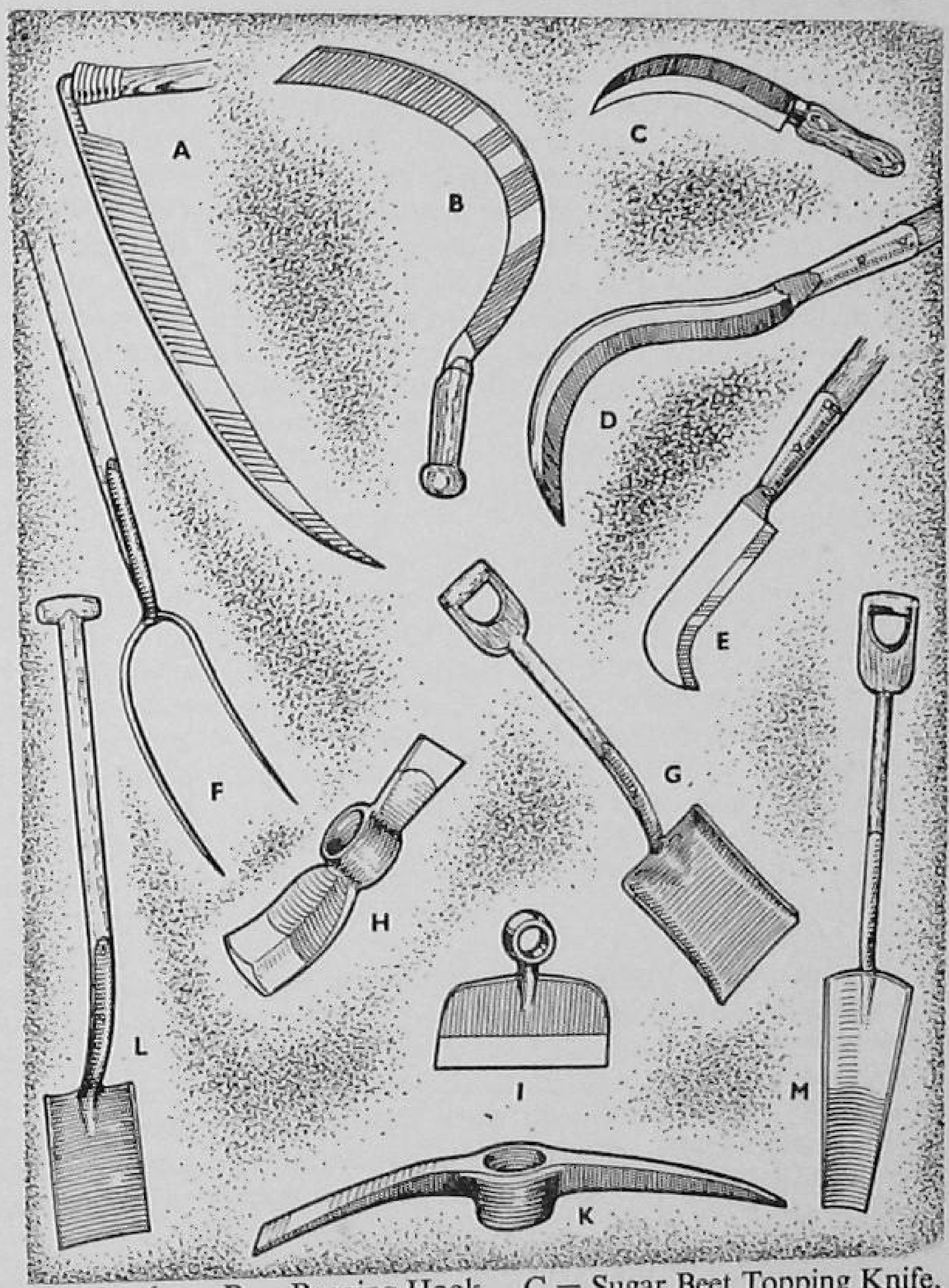
Shovelling.

Shovels are used for moving artificial manure and grain and seeds. Most of them have a wide flat area, with steeply turned-up sides.

Shovelling is nearly always done from heaps, and it is better to attack the heap from the side rather than from the top. Then the shovel can be kept nearly horizontal while the blade is being pushed into the heap and withdrawn, and so no levering movement need be given to the blade while it is embedded in the material.

Some handles for spades, forks and shovels end in a T-shaped hand grip; others end in an eyelet, with the hand grip forming a bridge across the top of the two branches of a U-shaped member. Some workers prefer one kind of grip, others can get on well only with the other kind of grip.

Shovels and forks sometimes have long, straight handles. Scoop shovels for drainage work have handles of this sort and, of course, so have the two-pronged, curved-tine forks used for pitching hay. Some three- and four-pronged



A = Scythe. B = Bagging Hook. C = Sugar Beet Topping Knife. D = Brushing Hook. E = Slasher. F = Pitch Fork. G = Shovel. H = Grubbing Mattock. I = Hoe Blade. K = Pick. L = Spade. M = Drainage Spade.

manure forks have short handles, but they are straight with no hand grips.

Hook Knives.

Hook knives, in many forms and with many names, such as bill-hooks and bagging-hooks, and mounted on short handles and long handles, are much used on the farm for trimming hedges, clearing nettles and brambles, and even for cutting crops of peas and beans. They are gripped in such a way that most of the movement comes by flexing the wrist. Short swings are used, and the blade is made to describe a curving path round the thing it is cutting.

A shorter knife, with a hooked end of somewhat the same shape as the end of a bagging-hook, is used for topping sugar beet. The leaves and dome of the beets are cut off in the field. This has to be done carefully, because if too much of the root is cut off with the leaves, there is a loss of total root weight, while, if too little is cut off and any of the low-sugar green-coloured part is left on, the processing factory reduces the rate of payment by increasing the allowance for tare. The right place to cut at is the level of the lowest leaf scar.

The Scythe.

The scythe is a cutting blade attached to a long wooden haft which has two handle grips. The long sweeping movement of a scythe makes the mowing of corn or grass with it much less tiring than it is with a hook. Both hands are in use, and the operator does not have to bend his back. In a long day an acre of grass can be scythed, but scythes are used nowadays only for cutting awkward shaped small plots of grass, and for opening a path in corn for a reaper-and-binder.

Hay.

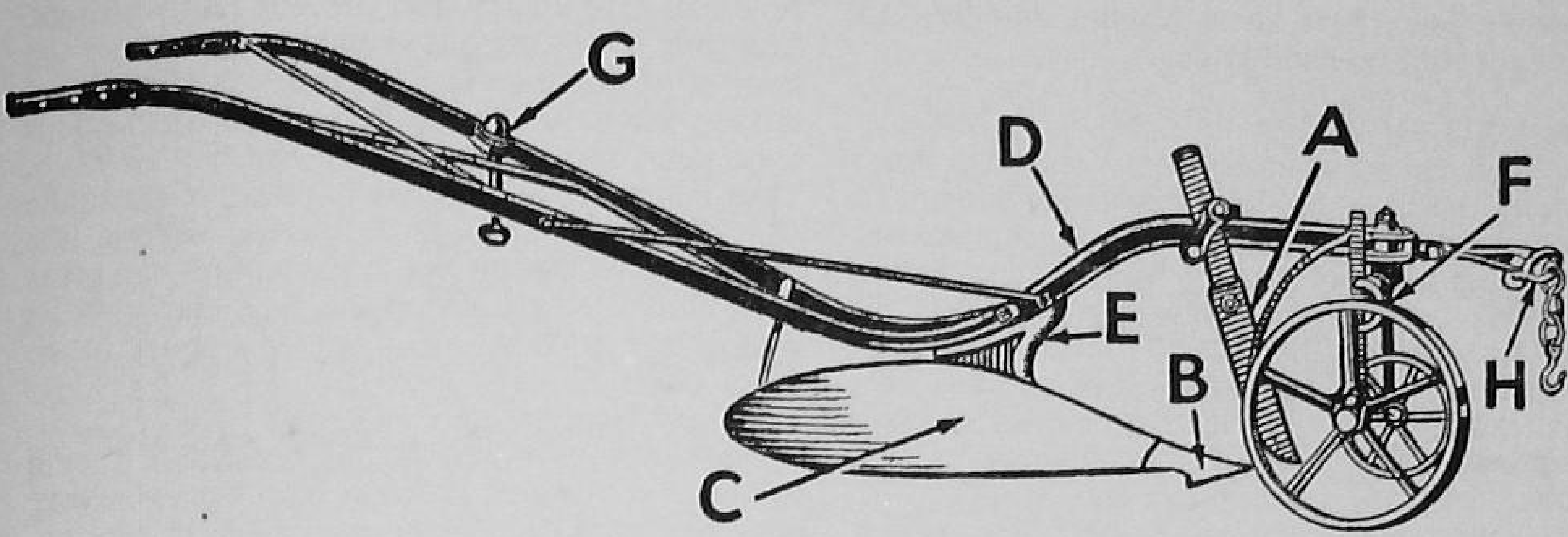
Hay rakes and hay forks are still much used, for it is rare indeed that the hay from every part of a field can be made and gathered in by the implements, and more sheaves of corn are still pitched by hand fork on to carts than by any mechanical means. Pitch-forking is certainly one of the jobs where a good rhythm and a right hold can save energy and prevent hand blisters. The fork is first thrust vertically down into the heap of hay or the sheaf of corn. A slight twist is then given to the handle of the fork. This twist helps the prongs to grip the hay or corn. Then one hand, holding the handle at the middle of its length, is used as a fulcrum so that the other hand, at the top end of the handle, can press downwards and so lift up the fork end with its load of hay or corn.

The Hand Hoe.

It is shown elsewhere in this book that hoeing between the rows of growing plants is, wherever possible, carried out by horse-drawn, or tractor-mounted, tools; but there is as yet no satisfactory simple machine for hoeing between the individual plants of each row. Therefore the hand hoe remains one of the most used tools even on farms that are highly mechanized in their other operations, and the usual practice is for the horse-hoe to be followed up by a group of men, each with a long-handled, rectangular bladed hoe. These men hoe between the plants. Also, in the case of a very valuable crop in which it has seemed too dangerous to set the horse hoe to work very close to the plants, they finish off the side hoeing missed by the horse-hoe.

Hoe blades must be kept sharp. In some models the rectangular blade is fastened directly to a socket into which the tapered handle is a push-fit; in others the blade is mounted on to a swan-necked member which is left permanently attached to the handle socket. In the first of these kinds the blade and socket are taken off together when the blade has to be sharped or straightened or renewed. In the second kind the blade can be removed from the swan-neck by loosening a set-screw.

For easy work one hand should be kept at the extreme end of the handle and the other at about half-way down. If the handle is clasped too near the blade, the worker's back has to be bent too much. For this reason a stout handle is better than a thin, springy one, since it more accurately reproduces at the blade end the movements given to it at the end where it is being held.



HORSE-DRAWN PLOUGH

The coulter, A, makes the vertical cut in the soil. Then comes the share, B, and next the curved mouldboard, or breast, C. The coulter is attached directly to the beam, marked D. The mouldboard is fastened to the frog, marked E, which is bolted to the beam. The wheels which carry the front part of the plough are mounted on vertical stems which are adjustable for height at the clamps, F, which hold them to the beam. The higher the wheels are set relative to the beam, the lower are the coulter, share and breast, relative to the wheels, and the deeper is the slice of soil cut by the plough. A spanner to fit the nuts of these clamps is carried in a socket at G so that it shall always be at hand for adjusting the depth of work. The plough is pulled through the hake, marked H. On the far side of the mouldboard, that is, on the left-hand side of it, is a long vertical cast-iron plate. This plate, called the landside, extends back from the share nearly to the back end of the mouldboard. The landside presses against the furrow wall, and absorbs part of the side pressure caused by the act of turning over the furrow slice. By absorbing the side pressure it helps to keep the plough running straight. Another plate, a horizontal one, called the slade or sole of the plough, slides along the bottom of the furrow and takes part of the downward pressure due to the weight of the plough itself and to the weight of the slice being cut and inverted. In many ploughs the landside and the slade are combined in one casting, shaped like a piece of angle-iron. At one time, plough mouldboards were made of wood. Now they are often made of three-ply steel. A layer of soft, tough steel is sandwiched between layers of hard steel. The soft centre provides the strength. The outer layers protect the centre layer from wear by abrasion by the soil. The shares are usually of cast iron, though some ploughs now have steel shares. Cast-iron shares are made to be self-sharpening. The under side is hardened more than the upper side, and so the upper side wears faster than the lower, and leaves the leading edge sharp instead of rounded.

TILLING

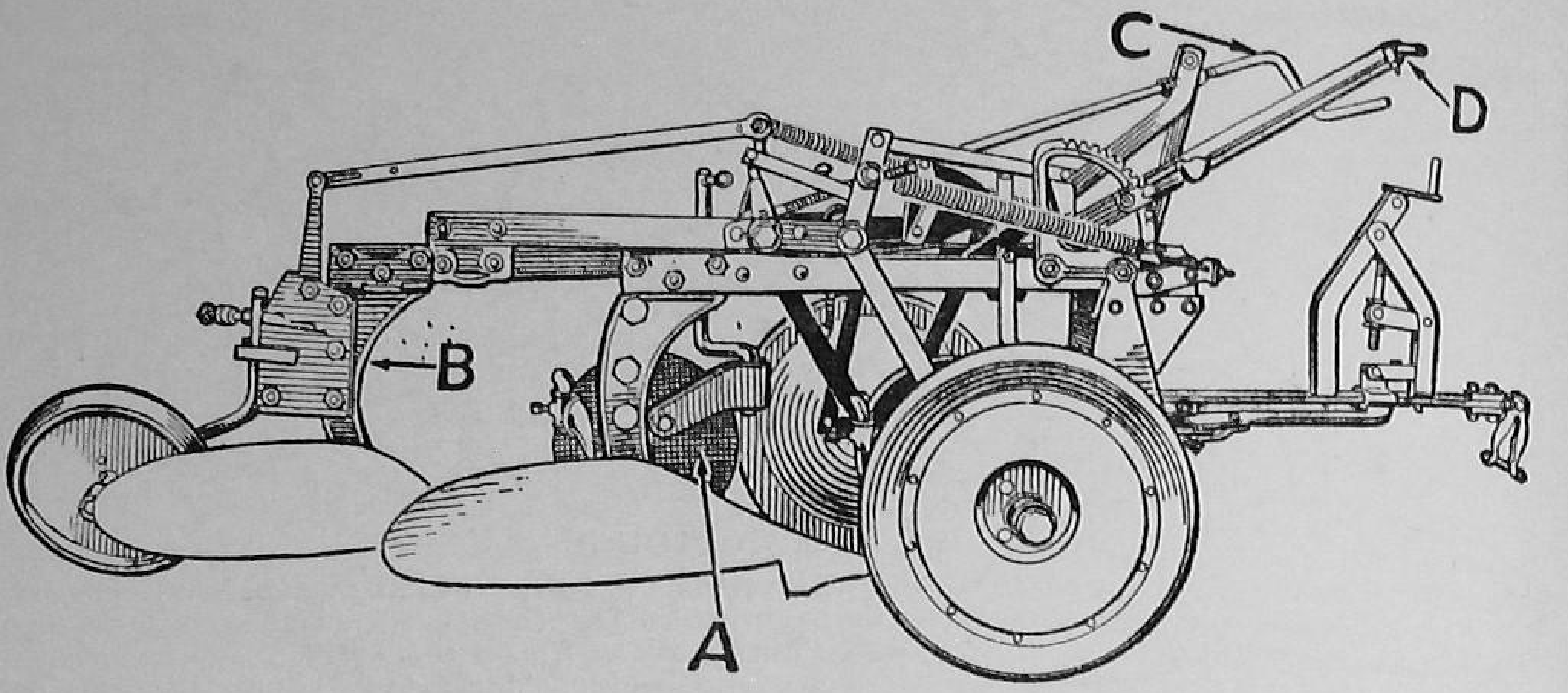
Our author introduces us to that ancient implement, the plough, traces its development for us, indicates its work and points out for us how the use of tractors has modified earlier practice. The work of cultivator, harrow and disc-harrow are explained and the section draws to a close with mention of the various rolls.

Ploughing.

The operation that comes first in the sequence of preparing land to bear a crop is ploughing. Also since ploughing uses more power than any other farm field-work, it has come to be considered first in importance as well as first in the season. But ploughing, as we understand it nowadays, the cutting of a strip of top soil and turning that strip upside down, has been practised only since Anglo-Saxon times. Early ploughs did not invert the soil, they only stirred it. Turning the soil upside down exposes it to the tilth-making influence of sun, air, frost and rain; also it buries weeds and last year's stubble to a depth at which they will decay and enrich the soil.

The lifting and inverting of the strip of soil is accomplished by allowing it to slide along a curved mould-board or breast. The complex form of curvature of the breast has been arrived at by generations of experiment. Ploughs made for different purposes have different curvatures of breast. The lea plough, used chiefly for ploughing up grassland, has a long, gently-curved mouldboard. This plough leaves a compact, upstanding slice which still retains the shape it had when it was severed from the ground. The digger plough, with a short, abruptly-curved mouldboard, breaks up the furrow as it is turned. This broken furrow-slice is more nearly ready to receive seeds than is the up-standing furrow slice from a lea plough, but some believe that it is not as ready to take advantage of valuable weathering effects.

The severing of the slice is brought about partly by a cut made by the share, a renewable, cast-iron, pointed knife fastened to the front of the breast. The share, however, is narrower than the width of the furrow slice; so part of the width has to be torn off. The resistance to this tearing forms a kind of hinge which holds the one edge of the slice to the ground while the other edge is toppled over.



TWO-FURROW TRACTOR-DRAWN PLOUGH

In this plough, disc coulters are used. One of them can be seen at A. The mouldboards are mounted on frogs, marked B, which are bolted to the beams. The beams are formed into a frame which can be raised, lowered, or tilted by moving the handles C and D. This frame, carrying the mouldboards, can be raised also by the self-lift mechanism, quite independently of the adjustments made by handles C and D. The lifting mechanism, working automatically by energy derived from the forward movement of one of the front wheels, is used for raising the mouldboards high enough to be right out of the soil. The ploughman uses this lift to put the plough out of work when he reaches the headland at the end of the furrow. Spade lugs have to be fitted to the rim of the wheel which provides the power for the lift, to help its grip. The rear wheel is not vertical; its axle is inclined so that the wheel is tilted away from the furrow wall and can the better take care of side pressure caused by the working of the plough. On some multi-furrow ploughs no landsides at all are fitted. On other makes a landside is fitted to the front mouldboard only. At the front of the drawbar in this picture can be seen the hinged clevis for attaching the plough to the drawbar of the tractor. Behind the clevis is an adjustment for moving the plough sideways relative to the direction of travel of the outfit.

The vertical cut of the furrow slice is made by another knife, called the coulter. The coulter can be either a fixed upright blade, or a steel disc with sharpened edges.

These three components—the share, the breast and the coulter—are the essential parts of a plough. The beams, frame and wheels are there only to hold these parts in their correct positions relative to each other, and to provide a means of pulling them through the soil at the right depth and in the proper position.

The depth of work—and therefore the thickness of the slice—is controlled by raising or lowering the frame on the wheels. In a simple horse-plough this is done by sliding the stub axles, to which the wheels are attached, up or down. In a multi-furrow tractor-drawn plough the stub axles are hinged, and they are moved by winding a handle which turns a coarse-threaded screw in a threaded collar.

At the end of each bout of work the plough has to be lifted out of work, so that it can be turned and brought into the next bout. With the single furrow horse-plough this is done very simply by bearing side-ways on the handle to cant the whole plough over on to one wheel. On a multi-furrow tractor-plough a self-lift arrangement is provided. When the plough is approaching the end of the bout, the ploughman pulls a trip cord which brings into engagement a rack and pinion which, by using the forward movement of the wheels, lifts the plough bodies, or bottoms, upwards relative to the wheels. Pulling the cord a second time causes the bottoms to drop back into working depth.

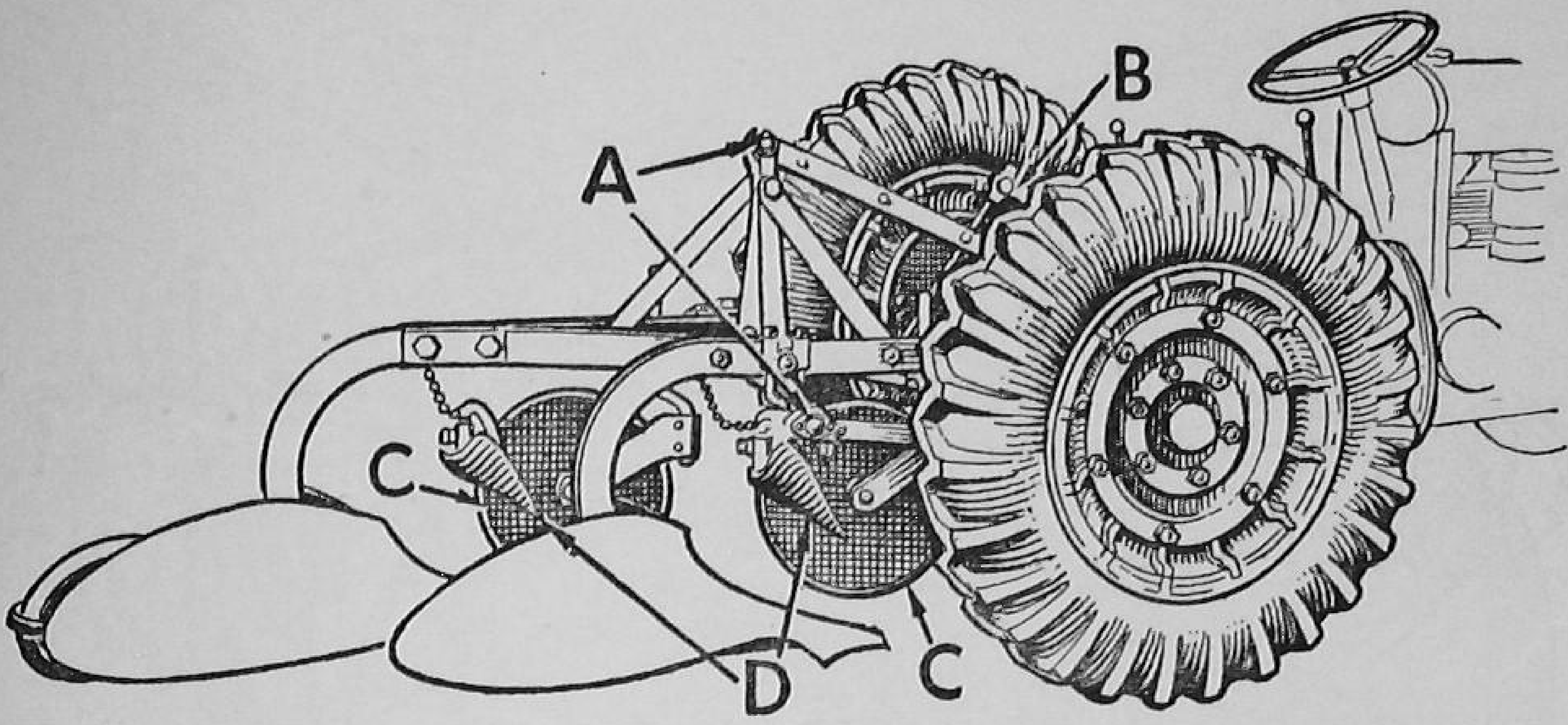
A horse-plough has a hook at the head to which can be hitched the whipple trees and traces for the horses; a tractor-plough has a hake, and a clevis which embraces the drawbar plate of the tractor.

Tractors.

Some tractors have provision for the plough and other implements to be attached directly to the body of the tractor instead of the implement being towed through a drawbar hitch. In that case no wheeled frame for the plough is necessary.

Cultivator.

When the land has been standing in furrow long enough for air, sun and frost to do their work, it is next broken up by a cultivator. The cultivator is a strong steel frame to which are attached spade-like tines which are drawn through



A DIRECTLY-MOUNTED TWO-FURROW PLOUGH

This plough is attached to a tractor which has a hydraulically-operated lift and depth-control unit. Two of the three points of attachment can be seen at A. The whole plough can be tilted sideways by the lever at B. The disc coulters, C, are fitted with skims, D. These skims are miniature ploughs which cut a strip off the edge of the top side of the furrow slices so that no vegetation shall remain along the crests of the laid slices.
A directly-mounted plough can be made lighter in weight than a tractor-drawn trailer plough, since it can have a much simpler frame. Also the outfit is shorter in length than a trailer plough outfit, so that at the end of each bout of ploughing the plough can be left in work longer. This makes possible a narrow headland, the strip of unploughed land between the end of the bouts and the hedge or fence of the field, and so less land remains to be ploughed by running the outfit round the edges of the field when the bouts are finished. A further advantage is that some of the weight of the plough, and some of the downward pressure due to the severing and inverting of the furrow slice, is carried by the tractor and keeps the grip of the driving wheels.
In the outfit in this picture, the lifting mechanism holds the plough at the depth of work required. The depth can be adjusted by a lever on the tractor. On some other outfits, the lift mechanism only raises the plough and holds it out of work. The depth of ploughing is controlled by land wheels which take part of the weight of the plough.

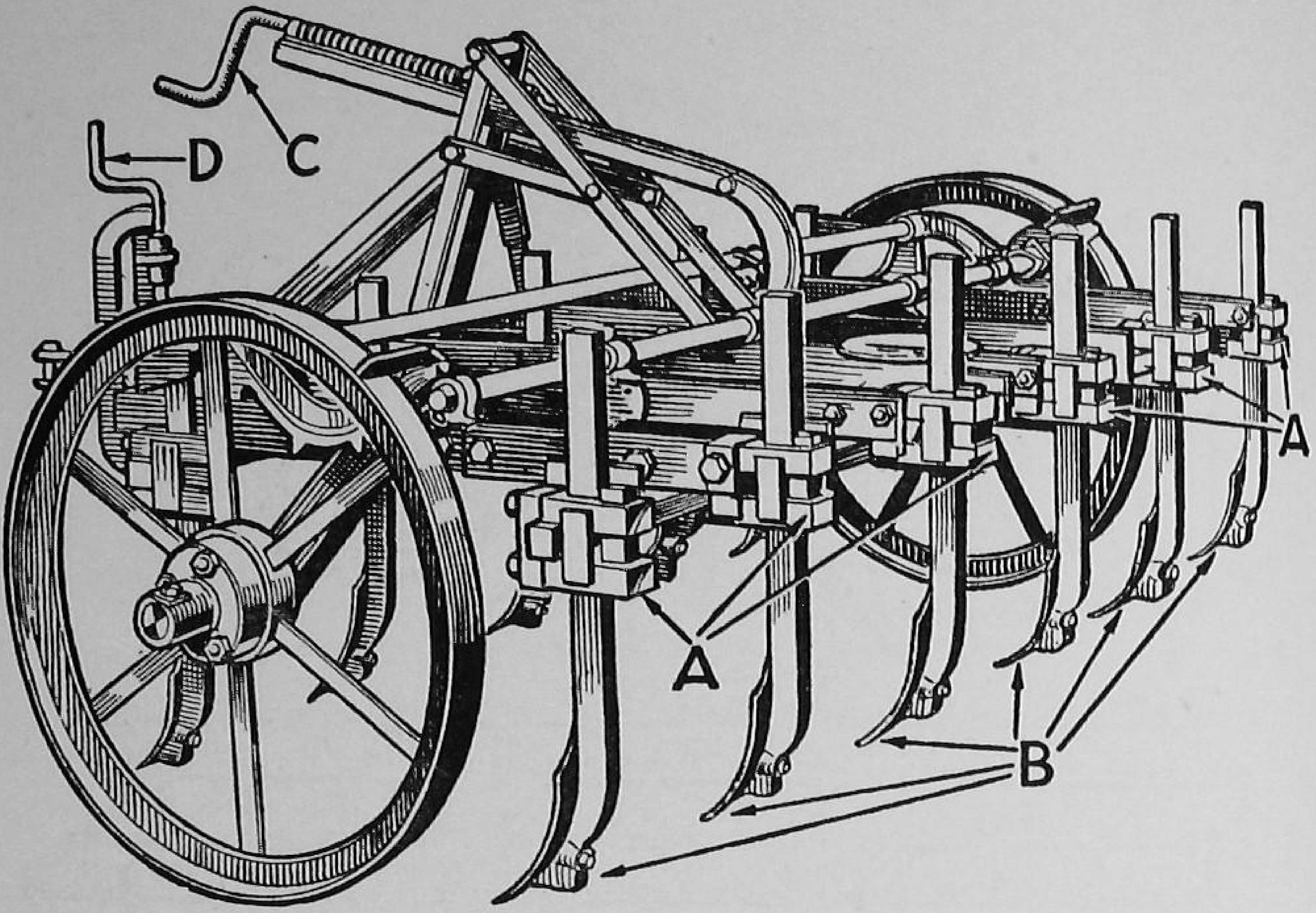
the soil. Each tine is fastened by bolts to a vertical stalk which can be made to slide up and down through a clamp on the frame of the implement. This gives a method of adjusting the depth of work of each tine, but usually there is also a method of raising or lowering the whole battery of tines at once. Also, on tractor cultivators, there is a trip device for lifting the whole framework high enough for all the tines to be out of the soil. Cultivating to a reasonable depth is hard work, and therefore the whole frame and wheels have to be very stout. So heavy is the draught that when the cultivators were first introduced to Britain from America in the middle of last century they were called " horse-breakers."

Harrow.

The cultivator, though it does break up the large clods of soil, does not, under most soil conditions, produce crumbs of soil fine enough for a seed-bed. To get this finer tilth a harrow is used. This is a lighter implement than the cultivator. Its tines are thinner, but they are placed closer to one another. One kind of harrow, the zigzag harrow, is a criss-cross frame. At each corner of the squares, or parallelograms, which make up the criss-cross, is fixed a pointed tine, about six inches long and three-quarters of an inch thick. Another kind of harrow has its tine points fixed on the end of a loop of spring steel. The spring causes the tine to vibrate in the soil, and this vibration helps to stir the soil into a fine mulch.

The Disc-Harrow.

A more modern implement, the disc harrow, is used to do the work of both a cultivator and a harrow. The discs are not flat like plough coulters; they are concave. They are arranged in gangs of about eight discs. Each gang has a single axle on which the discs rotate, each disc being separated from its neighbour by spacing washers. The line of the axle of each gang can be adjusted relative to other gangs. If the axles are all parallel to one another and perpendicular to the direction of travel, the implement does its lightest work. If the axles are inclined so that



A CULTIVATOR

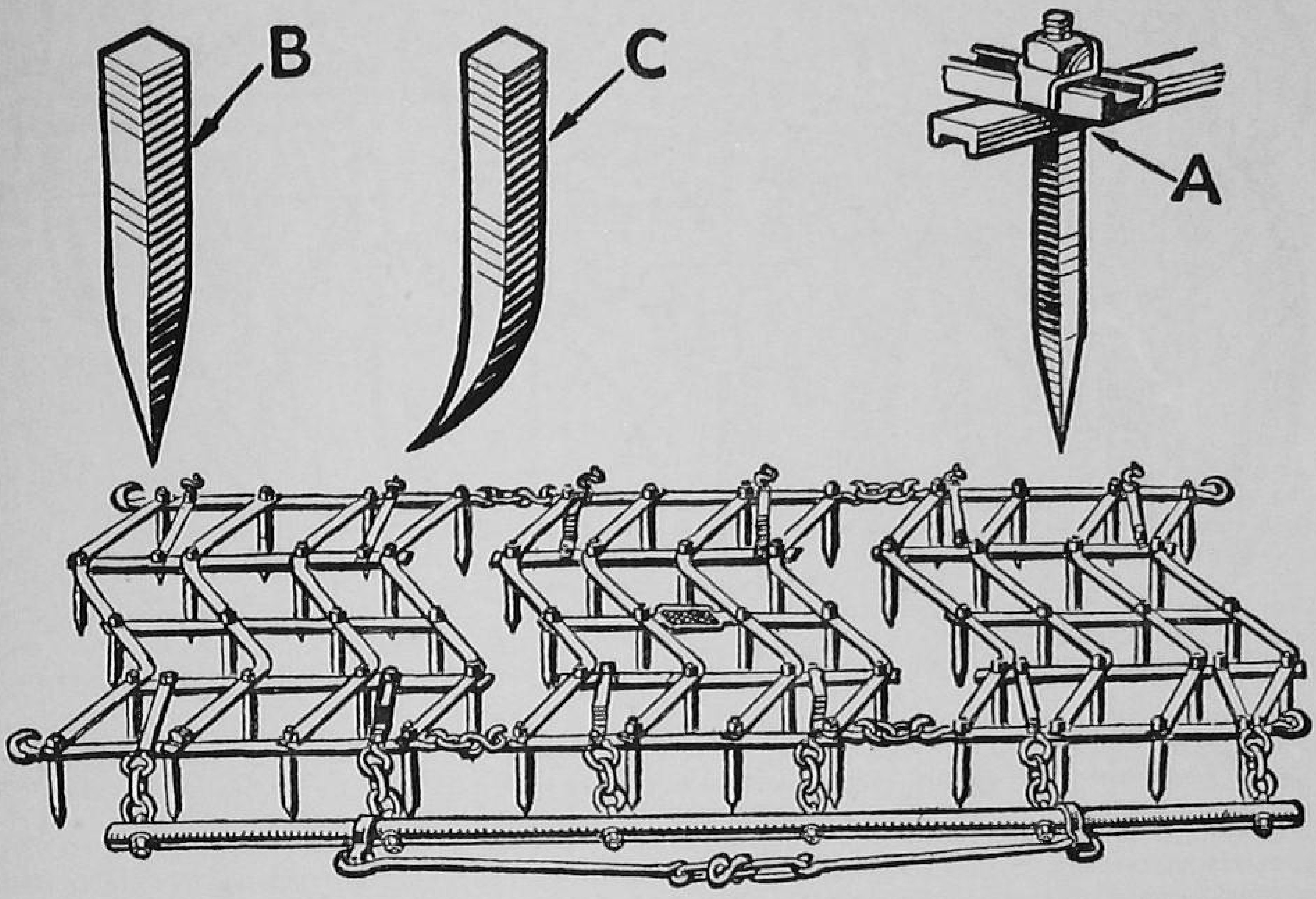
This very heavy implement has massive clamps at A to hold the tine stalks to the frame. The tines, or shovels, B, are detachable so that they can be replaced when they are worn. The tilt of the frame, and its distance from the ground, can be adjusted by the handles C and D. Greater changes in the depth of work can be made by loosening the clamps, A, and sliding the stalks up or down into a new position and re-tightening the clamps. The implement has a self-lift for raising the frame clear of the ground for turning at the headland and for transport to and from the field. The lift works by changing the angle of the stub axles on which the wheels are mounted. Several different kinds of tine are fitted to cultivator stalks, and the implement really serves quite a different purpose according to which tines are used. Narrow chisel points are used for bursting up land that has become hard and for breaking down furrow slices after ploughing. Wide shovel shares are used for shallow working to kill weeds. Broad shares with semi-circular sharpened edges convert the implement into a thistle-cutter.

each disc is at an angle to the direction of travel, the discs pulverize the soil more completely, and also cut deeper into the soil. The crumbled soil is pushed a little to the concave side of each disc.

The bearing of each disc is usually lined with wood instead of metal. When the harrow is working in dry weather the discs run in a cloud of dust; then, naturally, some of the dust get into the bearing. This grit scratches the surface of metals which are moving over the face of one another. Lubrication with oil does not help very much, because the grit and the oil form a grinding paste very destructive to all metals. But if one of the surfaces is wood the grit can embed itself into the surface of the wood, and so not press hard against the metal surface. A well-lubricated wooden bearing soon takes on a hard glass-like surface which resists wear and yet that hard surface is on a yielding, springy foundation which can give way to absorb dirt.

Rollers.

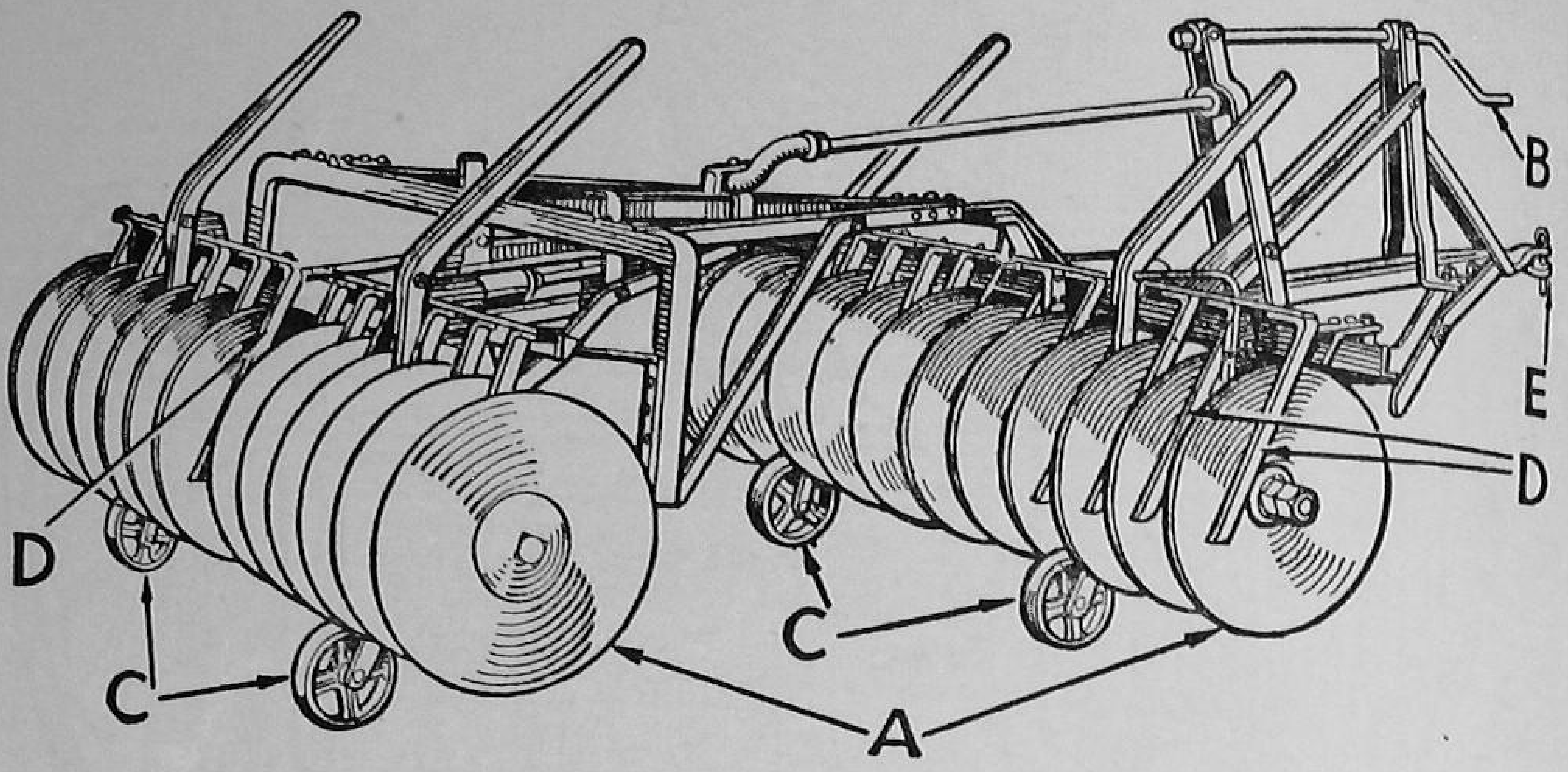
Rollers break up the clods still smaller and also consolidate the soil. Some rolls are called flat rolls; other, called Cambridge rolls, are made up of sharp-edged wheels. These ring rolls break up the clods more thoroughly than do flat rolls, because they cut them up as well as break them by the pressure of their weight.



A ZIGZAG HARROW

The tines, or teeth, are fastened at the corners of the parallelograms made by the frame members. The shape of the frame is staggered, or zigzag, so that the tines do not follow directly behind one another. Each one makes a separate track for itself in the soil. The enlarged drawing at A shows how the tines themselves, with a screw thread turned on them, are used as bolts to hold the members of the frame together on this particular make of harrow. The usual shape of tine is shown at B, but sometimes tines with curved points, as at C, are fitted in such a way that the points face in the direction of travel of the harrow. The straight tines are used for preparing seed beds and for covering seeds when they have been sown. Therefore a zigzag harrow, fitted with these straight tines is called a seed harrow. The curved tines are more often used for dragging couch and other weeds out of the soil, and so they are called drag harrows, or simply drags.

It will be seen that the harrow is made in sections, held together by chain links and fastened to a bar. This bar, to which can be connected the trace chains for horses or the link for a tractor, is called the whippletree. The fact that the harrows are made in these sections which can easily be detached from each other or fastened together again, makes the harrows more convenient to store and to carry to the field in a cart. For tractor work, many more sections than the three shown here can be used. The draught of the implement can be varied by connecting more, or fewer, sections, according to the power of the tractor and the condition of the soil being harrowed.

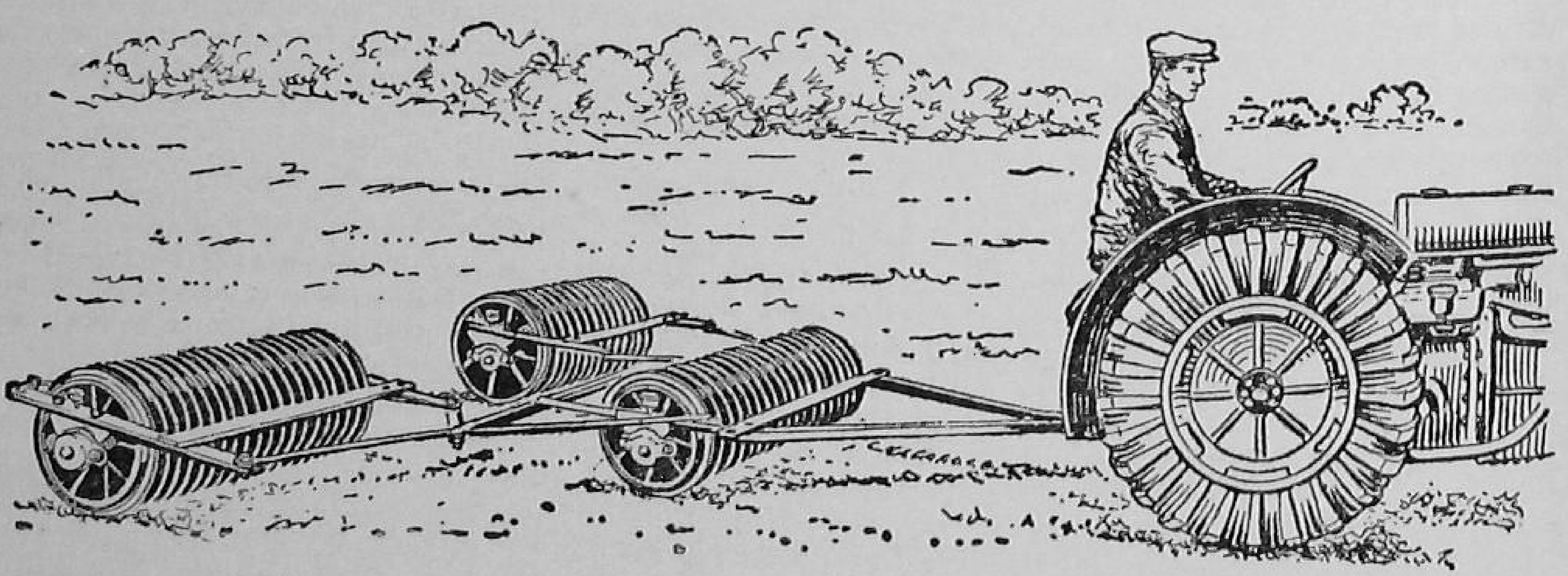


A DISC HARROW

The steel discs, A, are slightly concave. The harrow, in this picture has been adjusted by handle B until the axles of each pair of gangs are in line, and small transport wheels, C, have been fitted to the frame, so that the implement can be towed along the road without the discs being worn by contact with the hard surface. D are scrapers which remove any lumps of mud which stick to the discs when they are at work. E is the drawbar hitch for attaching the implement to a tractor.

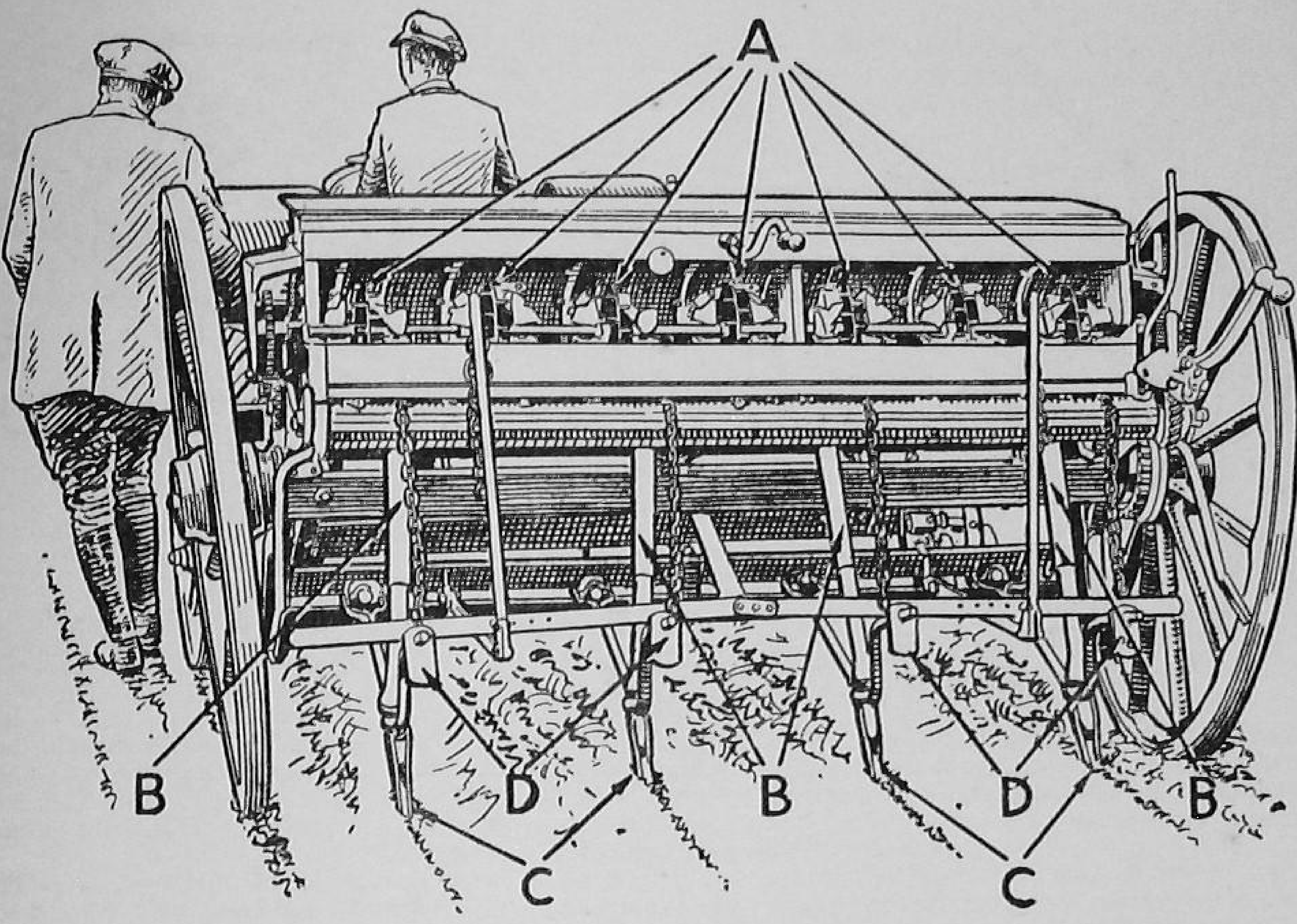
It will be seen that the discs of the nearside front gang have their concave surfaces facing outwards, while the discs of the nearside rear gang have their convex surfaces outwards. This causes the crumbled soil to be pushed a little towards the outer edge of the implement by the front gang and back towards the centre of the implement by the rear gang.

If the harrow were used on the field with the axles of each pair of gangs in line, the tool would be working at its lightest. Putting the axles out of line causes the discs to run at an angle to the direction of travel. This produces greater pulverization of the soil and deeper penetration of the disc into the soil, and increases the draught of the implement.



A GANG OF ROLLS

This Cambridge, or ring, roller is made in three sections, because a single roll having as great a width of work as have these three sections would not pass through ordinary field gateways nor be safe to take along a high road. For transport the three sections are rearranged one behind the other. The sections of the roll are not cylinders of iron, all in one piece. Each " ring " is separate and is individually mounted on the axle. Therefore, when the outfit is turning a corner the rings to the outer side of the curve are able to rotate faster than those on the inside of the curve. This articulation of the roll makes it less liable to tear out small plants when the implement is used on cornfields. Also the individual movement of the rings tends to prevent clods of soil building up on the surface of the roll. Some farmers prefer a flat, smooth roll for levelling land ready for seed to be drilled. The draught of a smooth roll is considerably lighter than that of a Cambridge roll of the same weight, width and diameter, because it does not bite into the soil.



A SEED DRILL

The drill in this picture has had part of the covering of the seed-box removed to show the cup-feed wheels at A. There are seven feed-wheels in this drill, but only four of the feed tubes, B, and coulters, C, are fitted, because root seed, not corn, are being sown. The seed outlets from the three cup wheels out of commission are shuttered off. Rows of roots are spaced farther apart than rows of corn would be. Weights, D, are attached to the coulter bars to help the coulters to keep their penetration in the soil and maintain the depth of planting. The cup-feed mechanism is driven through gearing from the land wheels. Drills, that is to say machines which cut a groove in the soil and plant the seed below the surface of the ground, are now used by nearly all farmers for planting corn and roots. Grass and clover seeds, however, are more often sown by a broadcasting machine. Broadcasters are much simpler machines than drills, since they have no delivery tubes or coulters. They consist of a seed box having a series of apertures cut in the back plate. Inside the box are circular brushes, one for each aperture, mounted on a shaft which is driven from the land wheels. The rotating brushes push the seed out of the apertures on to the land. The brush shaft rotates at a fixed speed relative to the speed of the land wheels, and the seeding rate is adjusted by changing the size of the apertures by a sliding door. Here, again, the broadcaster is a simpler machine than the drill, in which the change of delivery rate is achieved by changing the gear ratio between the land wheels and the feed mechanism. Broadcasting is, however, usually more wasteful of seed than is drilling, and, of course, cannot be used for crops which are going to be hoed by horse or tractor.

PLANTING AND HOEING

Conditions favourable for seeding are given, drills are described. Devices for planting potatoes are brought to our notice and mention is made of mechanical devices for transplanting young plants. An explantion is given of distributors for artificial and farmyard manures. Mechanical hoes are considered and finally there is a section on potato setting.

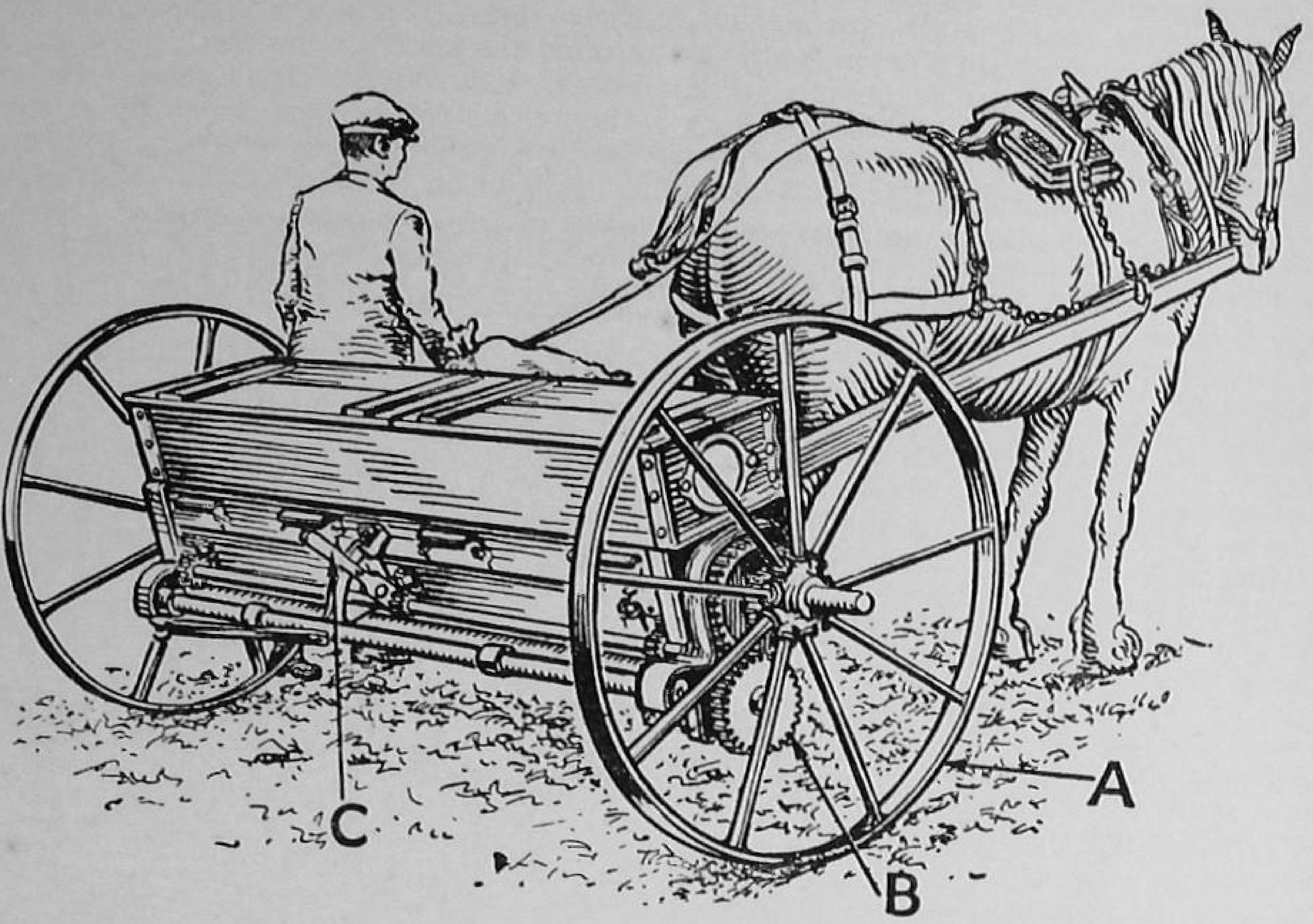
When the tilth is fine enough, and the weather is right for the soil to be powdery and not muddy, the seed is planted.

The Drill.

Corn, and some root seeds, are put into the soil by an implement called a drill.

The drill consists of a two-wheeled frame carrying a seed-box. From the bottom of this box come flexible pipes ending in a spout. Each flexible pipe or spout runs in the soil, in a groove opened for it by a coulter, with its opening half an inch to two inches below the surface. In some drills the coulter is a knife blade; in others it is a disc.

Now the seed has to get into the flexible tubes at a certain rate which depends upon how thick the sowing has to be. One method of



A MANURE DISTRIBUTOR

The mechanism of this machine for spreading artificial fertilizer powders is driven from the land wheels, A, through the gears, B. The manure is put into the wooden hopper, C, where it is stirred up and then forced out through slits on to the ground. The rate of distribution, relative to the forward speed of the machine, can be adjusted by the lever C.

It will be seen that manure distributors of this kind are really broadcasters. They do not drill the fertilizers into the soil; they leave it spread over the surface. There are, however, combined seed and fertilizer drills in which the fertilizer is delivered down the same tube and coulter as the seed. This ensures that each seed shall have at hand an additional source of plant food when it begins to grow. Combined drilling is becoming more and more popular for corn, although many farmers hold the view that in some kinds of soil, and for some kinds of manure, the fertilizer in this position is not only wasted, it is actually harmful. They consider that it slows down the germination of the seed and the growth of the shoots. A mechanical disadvantage is that the more complicated mechanism of the drill is more prone to corrosion and destruction by the fertilizer than is the broadcasting mechanism of a manure distributor. Great care has to be taken to clean out the machine after use, and particular attention has to be paid to loading the machine with only fine, free-running manures.

achieving this is to have in the seed-box wheels with little cups attached to their rim. These wheels, rotated through gearing from the land wheels of the drill, pick up a few seeds in each cup and then drop them into a hopper which leads into the flexible tube. The rate of seeding can be adjusted by changing the gear ratio of the drive between the land wheels and the cup wheels. Another mechanism used for picking the seeds up out of the box and dropping them into the hopper for the delivery tube, is a fluted roller. The seeds are carried round in the flutes of the roller. The fluted roller is a fairly close fit in its housing. The housing has an aperture at the side so that the seed can fall out and drop into the feed tubes. This fluted roller mechanism, called force-feed mechanism, is more positive than cup-feed mechanism and is not so much upset by the jolting of the drill over uneven ground.

The drills just mentioned are for seeds the size of wheat, barley and oats and the seeds of some roots. Small grass seeds can also be sown in the same kind of drill, but it has to be adjusted to deal with their smaller size. At the other end of the scale seed potatoes are now planted mechanically. The machine for setting potatoes in previously-prepared furrows or troughs in the soil can be merely a frame supporting a simple endless belt to which are attached cups. On the frame are

mounted a box to hold seed, and seats for one or two operators. The seed potatoes are put into the cups by hand. At a certain point in the travel of the belt, the seed falls out of its cup into a tube which leads downwards towards the planting trough in the ground. The belt is driven from the land wheels of the machine, through gearing suitably chosen to deposit the potatoes at the correct intervals.

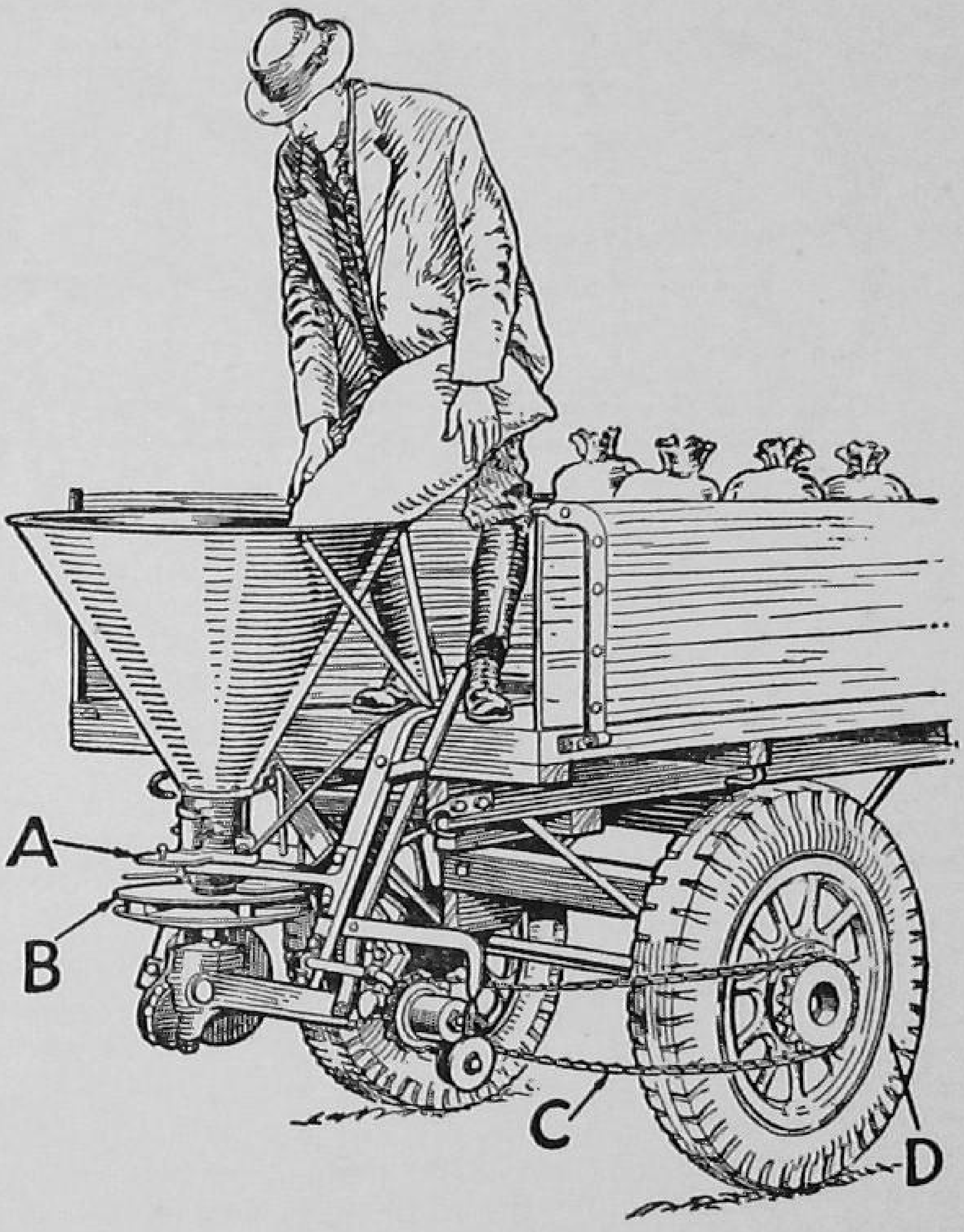
Planting Potatoes.

For planting potatoes on the flat, a combined furrow opener, planter, and furrow closer can be used. In the front of the machine is a plough board and share. In the middle of the machine is a cup-feed planter which can be adjusted to give various rates of delivery by changing pinion gears. At the rear of the outfit are two discs, side by side, running one each side of the row of planted potatoes. These discs are not parallel to one another; they are offset so that they pile up the soil over the row of potatoes and so close the furrow. Some types of these machines have, in addition, a device for spreading a little artificial manure along the furrow, in with the seed potatoes.

Transplanting.

While we are talking of machines for seeding it is worth while to mention also the mechanized methods of transplanting young plants, such as cabbage, broccoli and lettuce, an operation that occupies much time and uses much labour in market gardening. Quite simple slow - travelling frame - works, bearing a furrow opener and closer, and carrying boxes to hold the plants, and seats for the operators, can do away with the irksome back-bending which the Americans call "stoop work." The operators sit very near the ground and they dib the plants into the furrow as the machine moves slowly along the field.

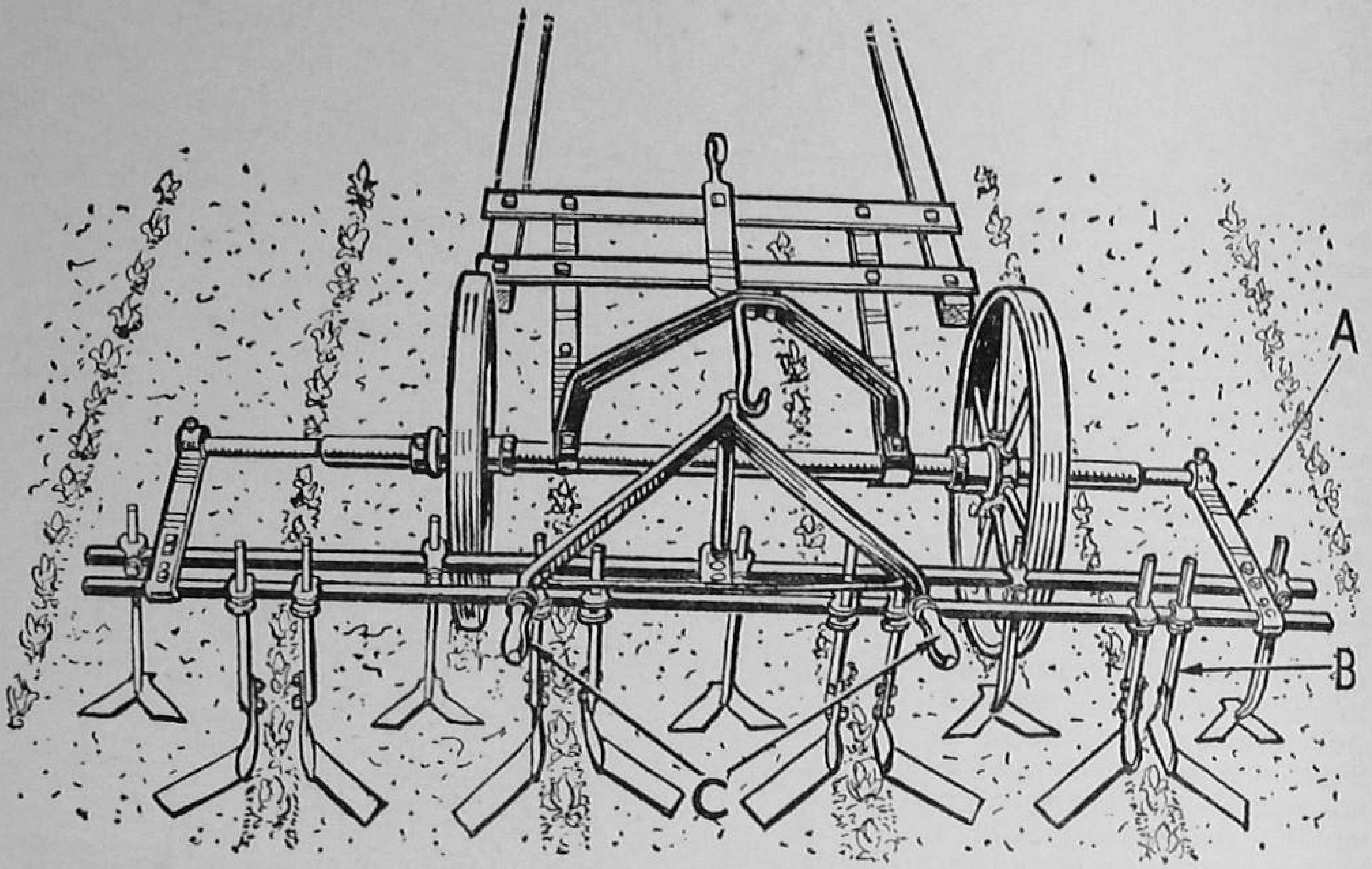
More elaborate is an endless belt type of machine. This machine can carry four operators, who take the plants from a box and place them one by one between rubber fingers on the conveyor belt. As the belt passes on these rubber fingers close and grip the plant and carry it toward the furrow in the soil cut by a coulter. The furrow is then closed by angled press wheels which consolidate the soil around the roots of the plant. At the same instant the rubber fingers release the plant. The release is brought about by a straightforward opening of the fingers, and the crumbs of soil which were originally clinging to the roots of the plant are not brushed away, as so often happens when plants are dibbed into the



A CENTRIFUGAL MANURE DISTRIBUTOR

This spreader is fitted on the back of a trailer upon which the sacks of manure can be carried. The manure is emptied into the cone-shaped hopper. When the shutter, A, is opened, the powder falls between the rotating discs, B, and is thrown outwards to fall on to the soil. The mechanism is driven, through a chain, C, from the land-wheel, D.

An advantage of this centrifugal type of spreader is that large quantities of manure, or of ground lime, can be spread; but if the machine is used in windy weather the distribution becomes uneven. A great advantage of the kind of outfit illustrated here, with the spreader attached to a trailer or lorry, is that the charge of manure which can be carried is so much greater than can be carried in the hopper of the more orthodox distributors. This can save much time, because however much care has been taken in dispersing the bags of fertilizer over the field, it is likely that when the hopper of a distributor becomes empty, the machine will be some distance from the supply. Moreover, less handling of the sacks is needed, because the trailer outfit can bring the bags of manure straight from the fertilizer store shed, and they do not need to be put down on the headland or field, where they may get damp.



A STEERAGE HORSE-HOE.

The frame, A, on which the hoe-stalks, B, are carried, can be moved to and fro sideways by the handles, C. The front member of the frame slides through the hollow axle of the carriage of the implement. This steerage device allows the hoes to be guided very accurately between the rows of growing plants. The implement is sometimes called a brake.

A steerage hoe of this kind can, of course, be towed by tractor instead of horse, but when this is done two operators are necessary, one on the tractor and one walking, or riding on a plank behind the hoe to guide the blades by means of the handles. For this reason, tractor hoes usually are fixed directly to the tractor and cannot be steered independently of it; the tractor driver steers carefully and knows that the hoes will follow fairly accurately in the same track provided he does not change direction too suddenly. This method is not, however, always exact enough for hoeing close to the plants, and there is much to be said for using a steerage hoe and a second operator even with a tractor outfit. In the case of a horse-drawn outfit, if the horse is well used to the work and the steersman is skilful in dealing with horses, no second man may be needed to guide the horse. In the implement in the picture, the hoe-stalks can be moved along the frame bars, and the wheels can be moved along the hollow axle, to suit any width of row.

soil. This machine has, also, a water tank. The opening of the outlet tap of this tank is synchronized with the plant releaser gear so that water is delivered into the open furrow at the root of each plant.

Distributor.

An implement not unlike the seed drill in some respects is the distributor for spreading artificial manure powders. The bottom of the transverse box, holding the manure, has slits in it to form a grid. Another grid, with similarly spaced slits, slides backwards and forwards in contact with the bottom of the box. When the openings of the slits coincide, the powder falls through them on to the ground. The reciprocating grid is driven through a crank from the land wheels.

Other types of manure distributor use other feed mechanisms. Some are rather like the fluted roller seed drill mechanism; others use a worm gear-wheel in which the powder is carried along the threads of the gear; some have a spiked

wheel to push the powder; and in others a stream of powder falls on to a horizontal rotating disc which whirls the manure outwards to spread it over quite a wide strip of ground.

Farmyard manure also can be spread by machine. The manure is loaded into a wagon having a false bottom. The floor is an endless conveyor belt. When this conveyor is thrown into gear, to be driven from the land-wheels of the wagon, it carries the manure slowly backwards towards the end of the wagon. At the back of the wagon are revolving beaters, also driven from the land-wheels, which tear up the manure and throw it on to the land.

Most root crops, such as lettuce, swedes and sugar-beet, are hoed between the rows to kill weeds. Corn crops are not now generally hoed, though some hoeing of wheat and barley is occasionally carried out in the eastern counties.

Hoe blades are fixed on to stalks clamped on to bars which are built into a wheeled frame like a very light cultivator frame. The hoe-blades used are of different shape according to the stage of growth of the plants being hoed, and the kind of soil-stirring that is required. The blades have names which are very descriptive of their shape. Ducks' foot hoes, "A" hoes, and "L" hoes are some of the names.

The Hoe.

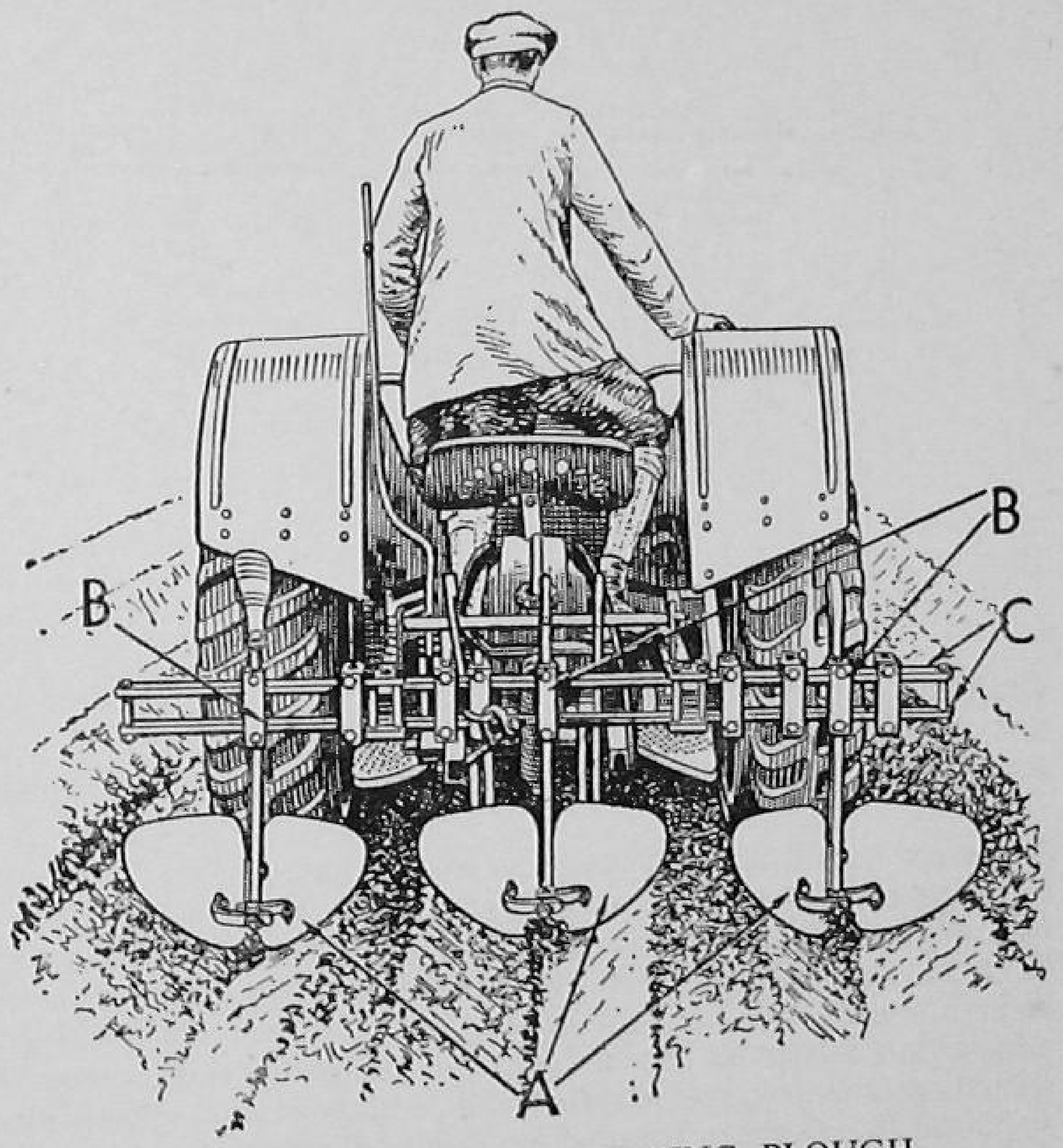
Steering the hoe between rows of valuable plants has to be done carefully if no plants are to be cut off and destroyed. In horse-drawn hoes the blade stalks are often mounted on a steerage frame which can be moved a little to the right or to the left independently of the main frame of the implement. The operator walks behind the hoe and controls the hoe frame by means of two handles like plough handles. Usually a second man, or boy, is needed to lead the horses.

Steerage hoes can also be drawn by tractor; but the modern tendency is to make a one-man outfit by mounting the hoes directly on to the tractor where they are under the eye of the driver. He can control their direction by steering the tractor.

Potatoes, when they are sown and cultivated in ridges, need special implements. The troughs are formed, in soil that has been well pulverized to form a suitable bed, by a symmetrical double mouldboard plough having a single share and two mouldboards, mounted one on each side of the share, like wings. These ridging bodies are often fixed on to cultivator frames after the cultivating tines have been removed, so that one frame serves two purposes.

Ridging Ploughs.

Ridging ploughs are towed either by horse or tractor. Accurate steering is necessary, particularly if the planted potatoes, called the "sets," are to be covered by "splitting back" the ridges. This is done by running the point of the ridging body right along through the middle of the ridge; then what was a ridge becomes a furrow, and the



DIRECTLY-MOUNTED RIDGING PLOUGH

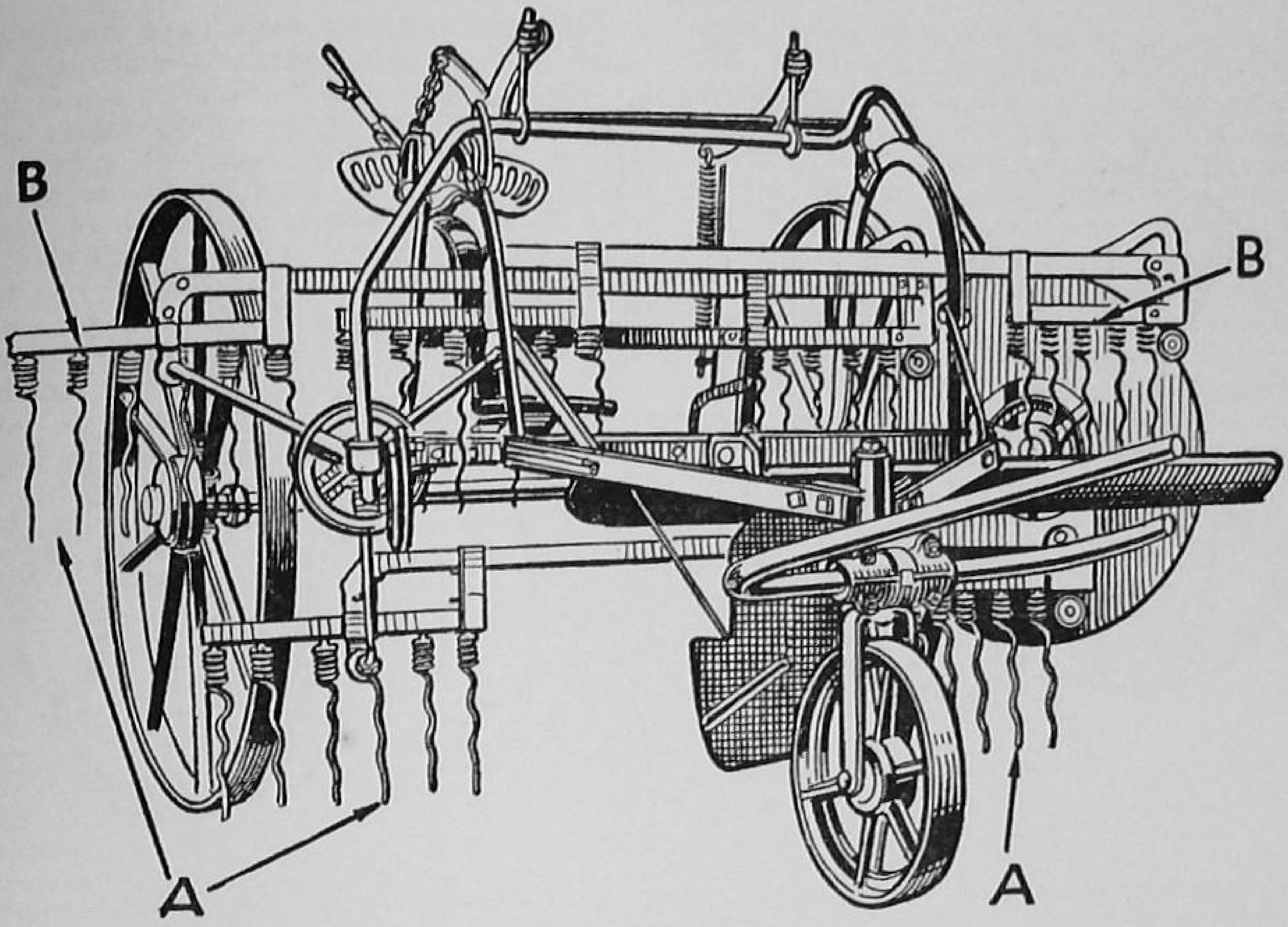
This implement is making bouts, baulks, or ridges, for setting potatoes. The three ridging bodies, marked A, are fixed to stalks which pass through clamps at B. These clamps can be moved along the tool-bar frame, C, to regulate the spacing between the ridges; and they allow, also, for the stalks to be adjusted individually for height. The angle which the two mouldboards of the plough body make to one another can be adjusted, and this adjustment controls the steepness of slope of the sides of the ridges.

The whole frame, holding all three plough bodies, can be lifted out of work by the lever beside the driver. This lever also controls the depth of work, and therefore the depth of the resulting ridges. The plough bodies and their stalks can be detached from the tool-bar frame which can then be used for cultivator tines or hoes.

Tool-bars can very conveniently be mounted on to hydraulically-operated lifts, to take the place of the hand-lever arrangements for lifting. Well-made hand lifts are not, however, hard to operate, because much of the work of lifting is done by a spring device.

soil thrown up on each side of the plough body to make the new ridges covers the potatoes. This can be managed very well with a horse-drawn ridger, because the man walks behind the implement and can steer it accurately. With a tractor-drawn set of bodies mounted in a frame it is difficult, because the tractor wheels must ride on the tops of the original ridges. If they ran in the troughs they would damage the set potatoes. It is almost impossible to keep the tractor on top of the ridges when it is pulling a load which, from time to time, is bound to exert cross-draught when one side or the other of the implement meets stiffer soil. The job is made easier by mounting the ridging plough frame directly on to the tractor. Even then considerable skill is needed to keep the outfit riding on top of the ridges. To make the operation easier, the original ridge is usually made with a flat top instead of with a sharp peak. The angle of the wings of the plough can be adjusted to make the desired shape of ridge at any given depth.

In some districts the sets are covered by breaking down the ridges with a harrow instead of splitting them back with the ridging plough. Whichever method is used, the subsequent earthing up and inter-row cultivation call for carefully steered tools.



A SWATH-TURNER

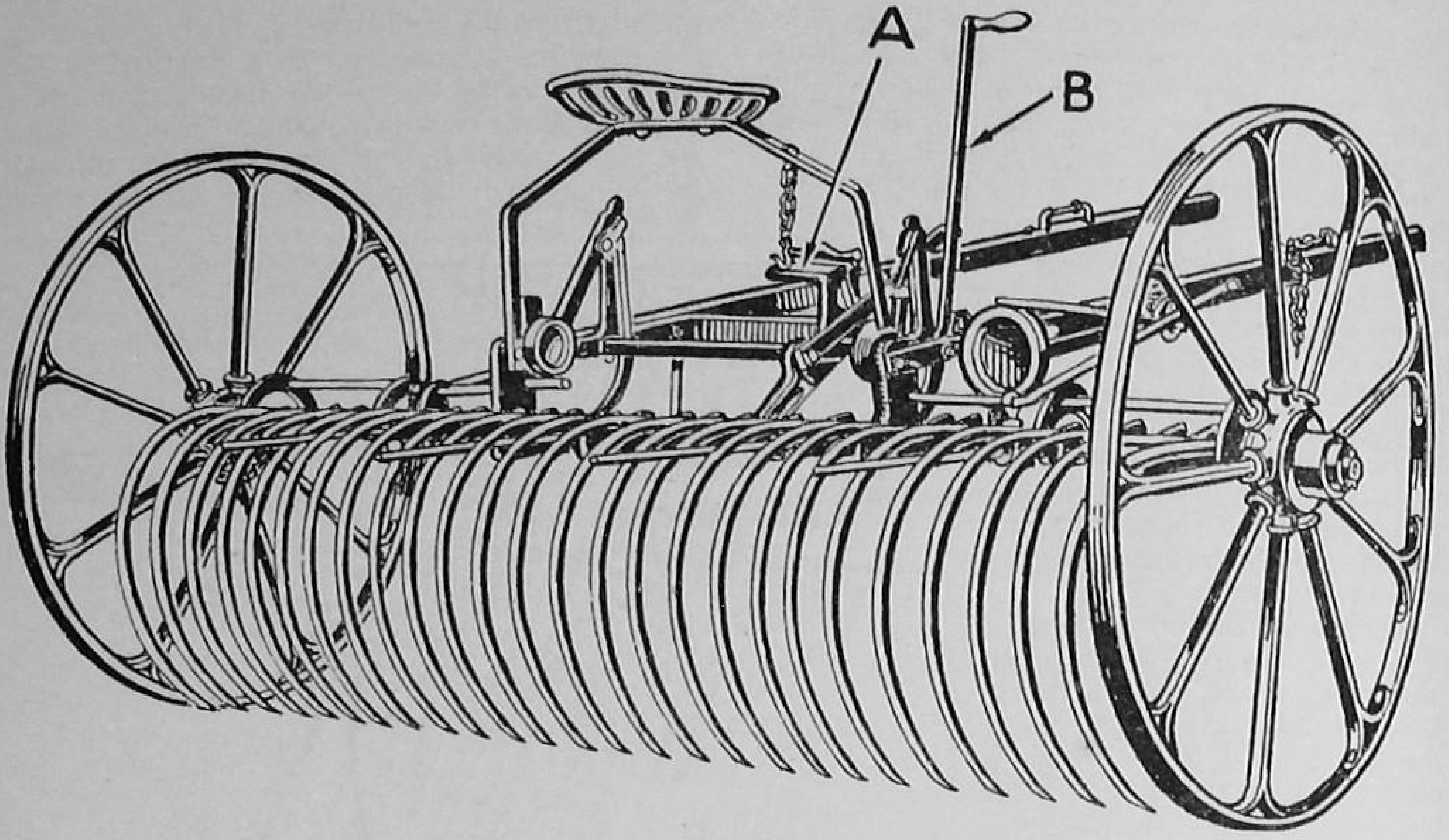
This hay-making machine, which deals with two swaths as left by the mower, has spring tines, A, attached to bars, B, which are driven from the land wheels. The tines remain vertical while they sweep through a circle whose plane is at an angle to the direction of travel of the machine. The tines from the mid part of the bars have been detached, so that the action of the machine is merely to invert the two swaths of cut grass. If tines were fitted all along the bars so that there were no gap left in the middle, then the action of the machine would be to sweep the swaths of grass over to one side of the machine, as well as inverting them. The swath-turner, set to act in that way, with all its tines in place, is called a side-delivery rake, since it leaves one windrow, thrown to the side of the implement, for every two swaths it has dealt with.

HARVESTING

Principles of mechanized harvesting are considered and the implements and their uses are brought to our notice. Emphasis is laid upon the need to save labour and make the best use of a short harvesting period. The history of hay-making devices is reviewed and the present position is considered. Silage making and the use of implements in its preparation are described. The corn harvest is described in relation to the mechanical devices by which it is facilitated. Grain-driers are not forgotten. The harvesting of root crops and potatoes is given detailed attention.

We have seen that many of the operations of preparing the soil and planting the seed and keeping the growing plants free from weeds are mechanized. The chief purpose of the mechanization of those operations is to save labour to make it possible for each man to control a far greater area of land. In some very few cases mechanization has also increased the absolute efficiency of the land in bearing food. An example of this is the "combine" drill which sows with each seed a little bunch of artificial manure to help the seedling in the early stages of its growth.

Saving of labour is always important to the farmer, but it becomes of the greatest importance when there is only a short season in which a certain operation can be properly carried out. For instance, in our climate there is only a very short period in which the soil can be made into a seed-bed and planted. To miss this period means planting the seed in soil not in the best condition to receive it; it may even mean having to forego getting in that particular crop on that particular field at all that year. It is, however, at harvest-time that the necessity of getting the job done quickly becomes most urgent. Hay-making and gathering, and even corn-harvesting, often have to be done in short spells of dry weather isolated in short spells of wet days. And the whole period is short between the day when grass has grown to sufficient bulk and the time when it has become woody, or the period between that



A HORSE-RAKE

The curved teeth collect the hay from the ground. When they have gathered a load, the operator can press the pedal, A, which causes the rake to lift high enough to drop the load. For travelling or running across a field, out of action, the rake can be fastened in the raised position by means of the lever, B. Some rakes, particularly those intended to be towed by tractor, are as much as ten and twelve feet wide. These are too wide to pass through gateways and to travel safely along a high road. They are, therefore, provided with a transport carriage on to which the rake fits in such a way that it will travel at right-angles to the direction in which it would be at work at the fields. On some makes of rake this same end is attained without the use of a separate carriage. The wheels are taken off their axles at the ends of the machine and are put instead on to a secondary axle which is clamped across the main frame of the rake at right-angles to the main axle. Whichever of the two methods is used, the horse shafts or tractor drawbar must be detached or folded upwards so as not to project sideways.

These methods of transport are used also for other very wide machines, such as seed drills and manure distributors.

moment when corn is ripe and the time when its grains begin to be shed on to the ground.

The Tedder and Horse-Rake.

It is not surprising, therefore, that much of the inventiveness given to agricultural machinery has been devoted to speeding the gathering in of crops. The first of the harvesting operations to be nearly completely and very efficiently mechanized was the cutting and gathering of hay. In the early part of last century the tedder and the horse-rake were beginning to be used instead of pitchforks to turn the cut grass over to expose fresh parts of it to sun and air to cure it, and to collect the made hay into heaps from which it could be hand-pitched on to carts to be carried to the rick. But the actual cutting of the grass was still done by scythe. However, in 1860 the mowing machine, very much the same as we known it now, came into use, and a man with a change of horses could quite easily cut ten acres of grass in a long June day. Later on came the elevator and the hay-loader and the horse-sweep, and also several haymaking implements such as the swath-turner and side-delivery rake.

Mowing Machines.

Mowing machines are built into and around a cast-iron frame. This frame contains the trains of gears which drive the cutting mechanism from the land-wheels of the mower. In the frame are openings for the main axle which carries the land-wheels, and for the crankshaft and the countershaft. The wheels also are of cast-iron, with transverse ribs cast on their rims to help the wheels grip the ground and so transmit the power needed to drive the mechanism. The heavy weight of the cast-iron frame and of the wheels themselves also helps the grip. In the hubs of the wheels are ratchets and pawls. When the mower is being towed forwards these pawls engage in the ratchets and form a positive drive to the cutter, but if the wheels are turned backwards instead of forwards, the pawls trip over the ratchet, with a clicking noise, and do not transmit the drive. This arrangement does away with the need

for differential gearing in the axle of the machine.

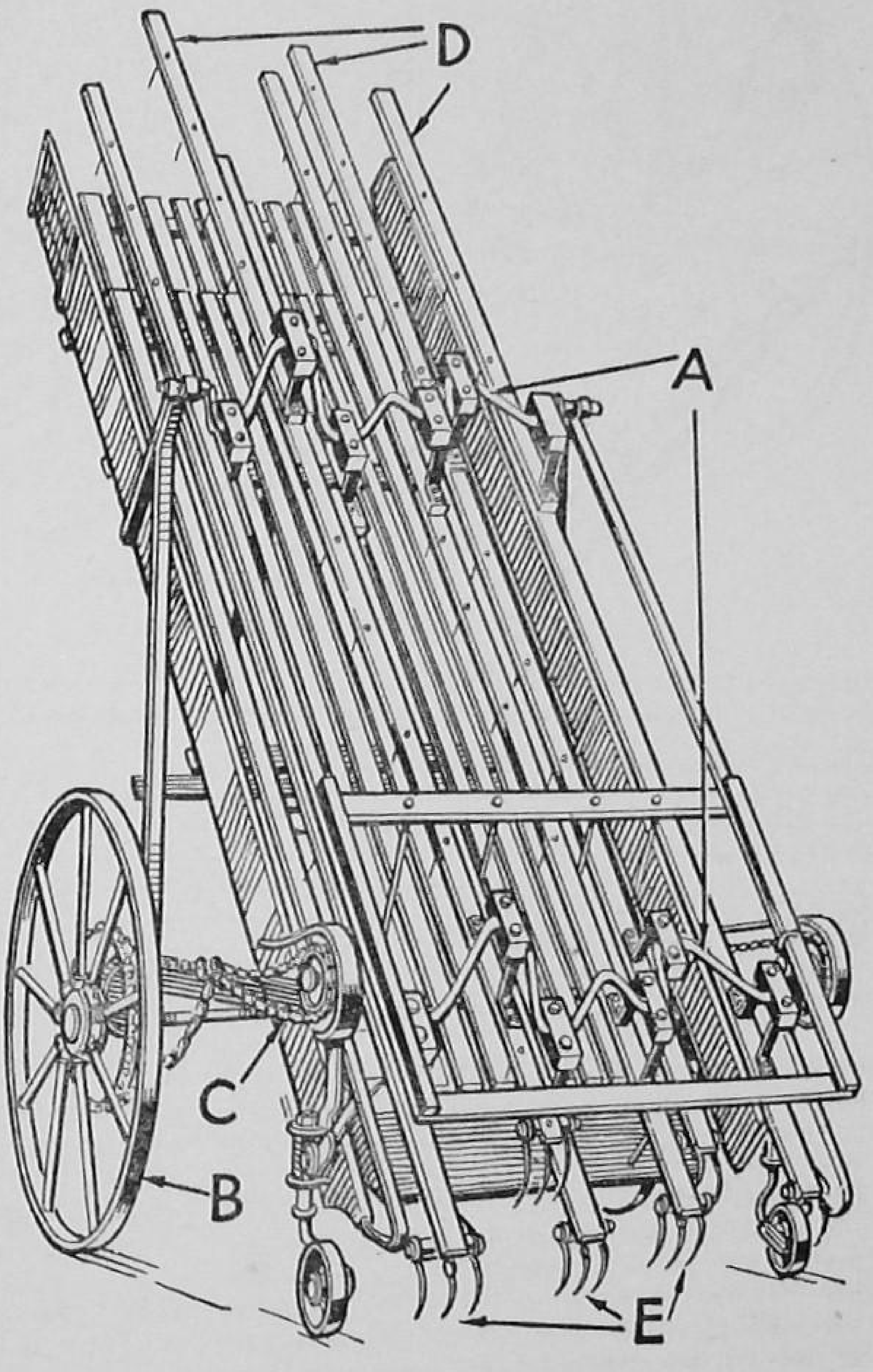
The moving part of the cutter-bar consists of a steel slat, usually four feet six inches long, to which are riveted triangular knives. These knives are about three inches wide at their base. The other two sides of the triangle are sharpened to an acute edge. This knife-bar, as it is called, reciprocates backwards and forwards inside a series of guards. The guards contain steel ledger plates which form the other half of the scissors for cutting the grass. A crankshaft converts the rotary movement, imparted by the land-wheels, into the to-and-fro movement for the knife-bar. The connecting rod is called the pitman.

At each end of the cutter-bar is a sledge, or shoe, which slides along the ground and keeps the knives at the right height to cut the grass. The outer shoe is extended backwards as a wooden board which directs the cut grass inwards to form a compact swath, or strip of mown grass, in the wake of the machine.

The whole cutter-bar can be swivelled upwards, pivoting on its inner end, so that the bar no longer cuts the grass and so that the machine can be taken through gateways. On most makes of machine this swivelling of the cutter-bar can be carried out by the operator on the seat, either through a hand-lever or a foot-pedal; and usually the lifting of the cutter-bar also automatically disconnects the drive to the knives.

Mower cutter-bars are made also for direct attachment to tractors. No frame for the mower is needed and the pitman is driven through a power-take-off from the tractor engine.

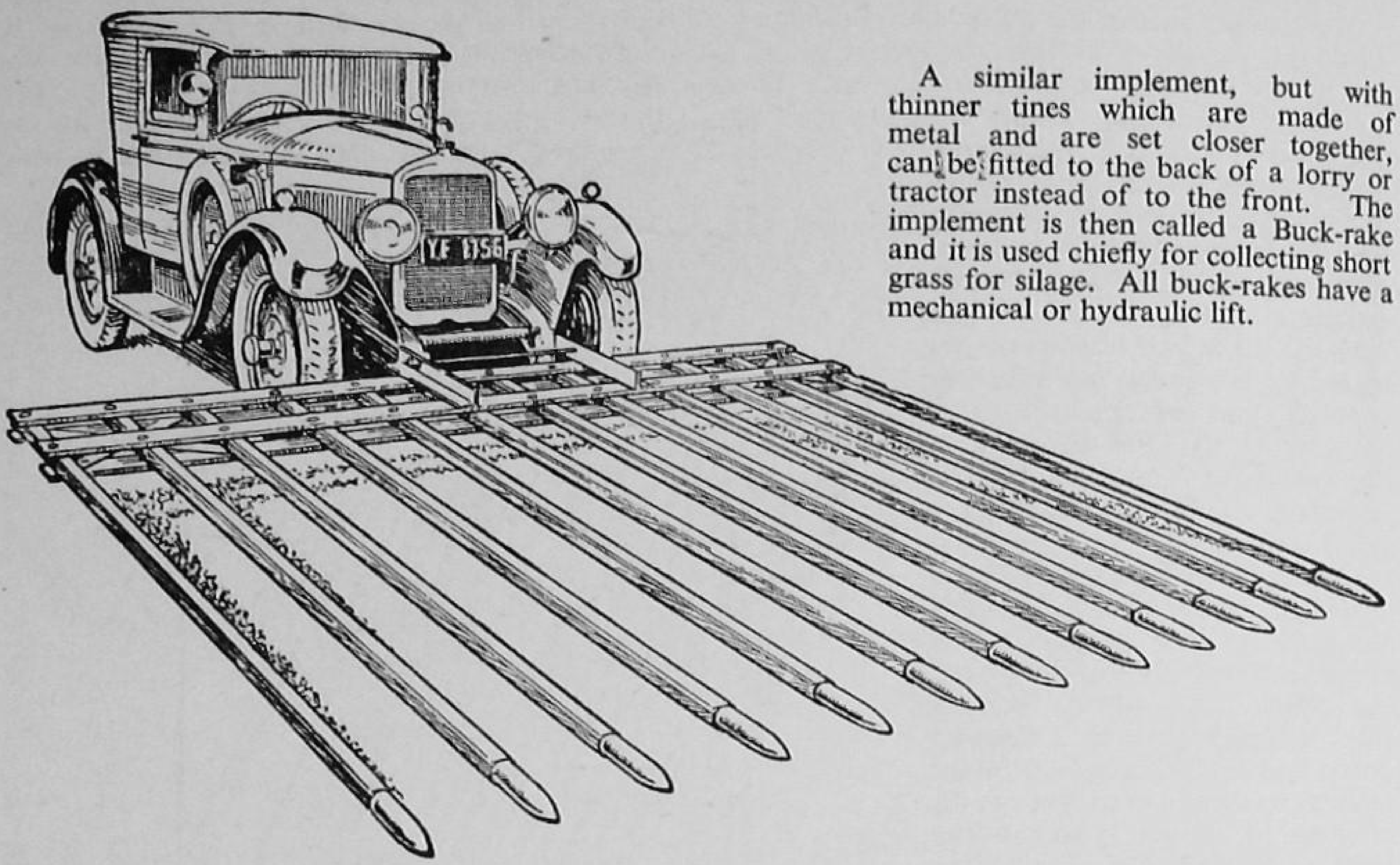
The swath of cut grass lies too compact for more than the top and sides to dry out and cure. Therefore the grass has to be scattered, or turned over to form a windrow, a row of grass on which wind can blow. One machine for doing this is called the swath-turner, and has spring loaded tines which remain vertical while they sweep through a circle. This movement is achieved by mounting the tines on bars. Two circular discs, parallel to each other, but not opposite to one another, are rotated through gearing from the land-wheels. Each bar bearing the tines has its one end in a bearing at the circumference of one of the discs and its other end in a similar bearing on the other disc. Thus the bars, usually four in number, move through an ellipse, and the plane of the circle in which



A HAY-LOADER

This device is trailed behind a hay cart. It picks up hay lying on the ground either in swath or windrow, and elevates it on to the cart. The two cranks, A, driven from the land-wheels, B, through the chains, C, cause the slats, D, to oscillate up and down. At the bottom of these slats are forks, E, which pick up the hay from the ground. Spikes are fitted all the way along these slats, and the reciprocating motion pushes the hay upwards to fall over the top on to the cart.

This kind of loader works best with long, well-cured hay. There is, however, a type which has a spiked cylindrical pick-up reel instead of the forks at the bottom of the trough, and has an endless-belt elevating apron instead of the oscillating slats. This second type does not deal quite as well with a long heavy crop as does the first type, but it has the great advantage that it will pick up, cleanly, short grass to be used for silage. Thus it is a machine that can be used both for hay making and and silage making.



A similar implement, but with thinner tines which are made of metal and are set closer together, can be fitted to the back of a lorry or tractor instead of to the front. The implement is then called a Buck-rake and it is used chiefly for collecting short grass for silage. All buck-rakes have a mechanical or hydraulic lift.

A CAR HAY-SWEEP

The long wooden tines are tipped with metal shoes to prevent the end of the wood from splitting or wearing out. Hay-sweeps were at first made for use with horses, and, indeed, many horse sweeps are still in use. Two horses. one each side of the rake, pull the sweep. On some sweeps in America the hitches are arranged so that the horses are actually behind the cross-member. Their trace chains, or shafts, are fastened to a second cross-member built on to a wheeled chassis having a seat for the driver.

On horse sweeps, and on most tractor sweeps, the rake can be lifted mechanically when it has gathered a full load of hay, to make the journey to the rick easier. No provision is made for this on car sweeps and lorry sweeps. On some tractor outfits the lifting mechanism of the rake can be connected with the hydraulic lift system provided for ploughs and tool bars.

the tines rotate is at an angle to the direction of travel of the implement.

Variations in the action and effect of the swath-turner can be obtained by changing the intervals between the tines along the bars. When the tines from the mid part of the bar are detached, leaving a group of tines at either end of the bar, the swaths are turned over, but are left in roughly the same places as they were before they were turned. When more tines are put on to fill in the space in the middle of the bars, two swaths of grass are swept together over to one side of the machine, as well as being inverted. When the machine is set to act in this way it is called a side-delivery rake.

The Horse-Rake.

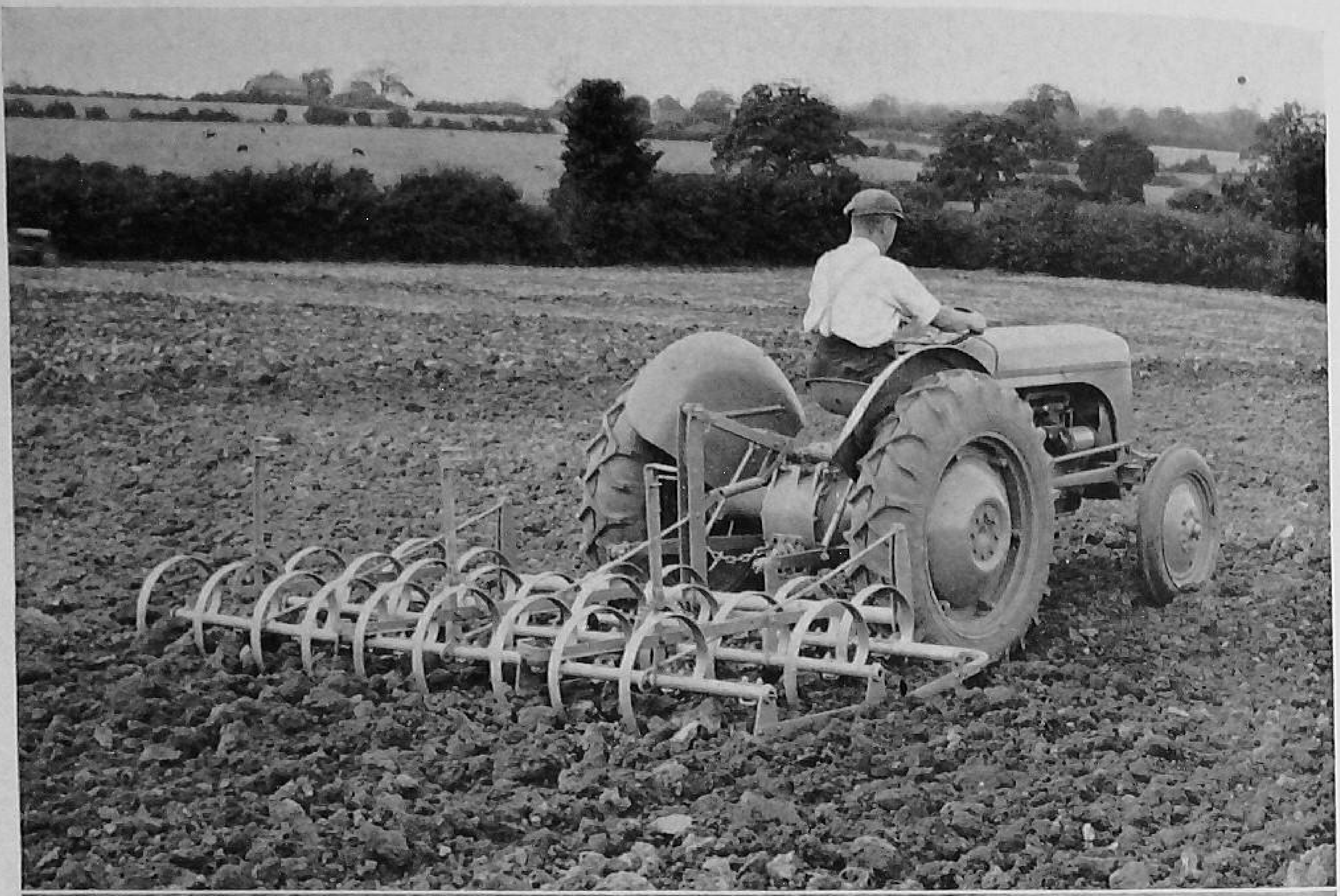
Another form of rake is called the dump-rake, or simply the horse-rake. It is a wide rake of curved metal teeth carried on a wheeled carriage drawn by horse. The driver sits on a seat on the carriage, and by depressing a pedal he can lift the rake high enough to dump on to the ground the load of hay that has collected on the teeth. A rake of this sort can be used to make windrows at right-angles to the direction of the original swaths. The driver travels along the swaths and presses the pedal at regular intervals. At the next bout he presses the pedal when he is alongside each bunch he left on his previous bout.

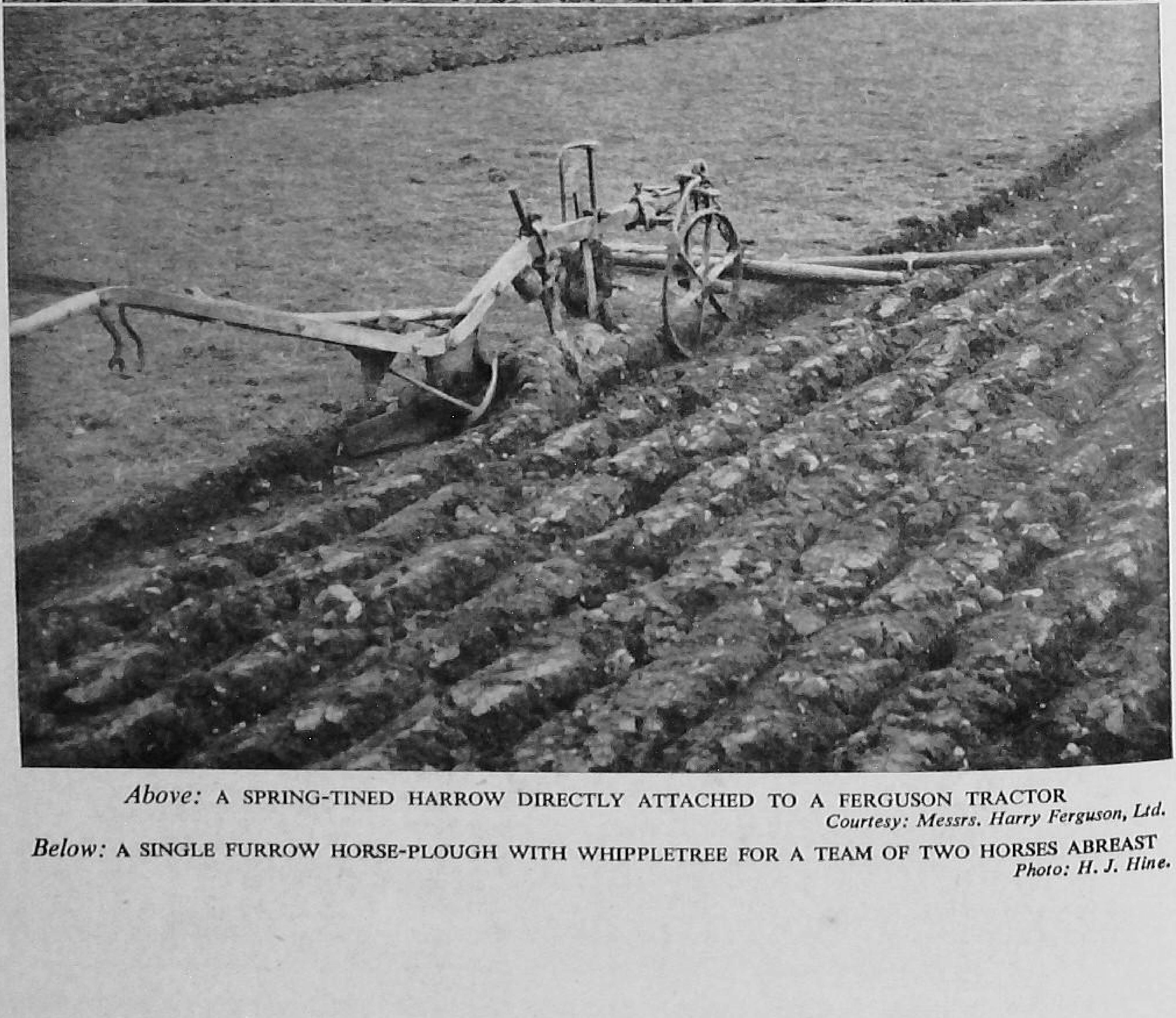
The Tedder.

There is yet another machine for stirring the cut grass while it is being cured. It is called the tedder, or haymaker, and it has rigid tines mounted on an axle driven from the land-wheels of the implement. The action of this machine is fierce, and it stirs the half-made hay so vigorously that it is apt to knock off some of the nutritious small leaves. It ought really only to be used when wet weather has caused swaths to settle into a compact mass.

When the hay has been cured it can be collected either by an elevator device which is attached to the back of a wagon, or by a hay sweep. The wagon-loader has spring-loaded teeth which sweep the ground and pick up the hay. In some types of loader the hay then travels upwards on an endless belt made up of steel slats; in other types

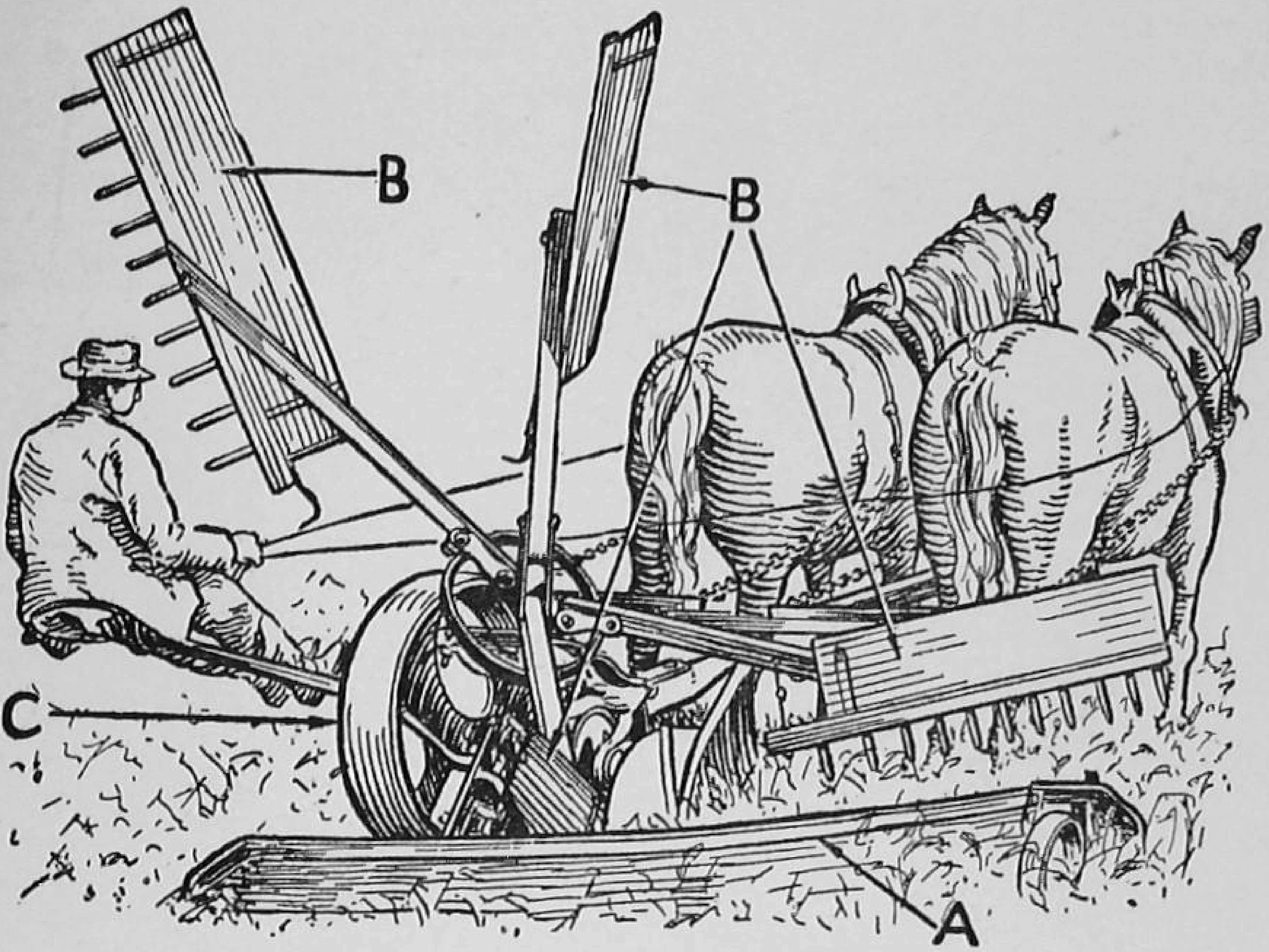
Above: A FIELD OF SUGAR-BEET
Below: SIMPLEX ELEVATOR DEALING WITH A HEAVY CROP OF SUGAR-BEET
Farmer & Stock-breeder Photographs.





Above: A SPRING-TINED HARROW DIRECTLY ATTACHED TO A FERGUSON TRACTOR
Courtesy: Messrs. Harry Ferguson, Ltd.

Below: A SINGLE FURROW HORSE-PLOUGH WITH WHIPPLETREE FOR A TEAM OF TWO HORSES ABREAST
Photo: H. J. Hine.



A REAPER

This machine, now used most for cutting peas and white mustard, is really a mowing machine to which has been added a device for causing the cut crop to be left on the ground in neat bunches instead of in a continuous swath. The crop cut by the reciprocating knife falls on to the platform, A. Sails, marked B, to which rakes, rows of teeth, are attached, sweep over this platform and push the crop, in bunches, over the side of the machine. There are four sails. If small bunches of the crop are desired, rakes are fitted to all four of the sails, but if larger bunches are desired the rakes are fitted to only two of the sails, as in this picutre. The rakes are removed from sails opposite each other, not from adjacent ones. The drive for the cutting knife and the rotating sails is taken from the main land-wheel, marked C, which is called the bull-wheel. Machines of this sort were at first used for harvesting grain.

inclined wooden bars, bearing metal hooks, reciprocate in and out of each other and cause the hay to work upwards to the top of the elevator.

Hay-sweeps, made up of long metal-tipped wooden teeth lying horizontally along the ground can be used with horses, or can be attached to tractors, motor lorries or high-powered motor cars. The sweep is driven along a windrow until a sufficient load has collected on its wooden teeth, and then the outfit is diverted from the row and driven to the place where the rick is being built. Reversing the outfit leaves the load of hay in a pile on the ground.

The Sweep.

The sweep method of hay collecting is quick, and efficient both in man-power and horse-power. It can, however, be used only on fairly flat fields and only on fields where the rick is to be built actually in the same field. A sweep cannot take its load along roads.

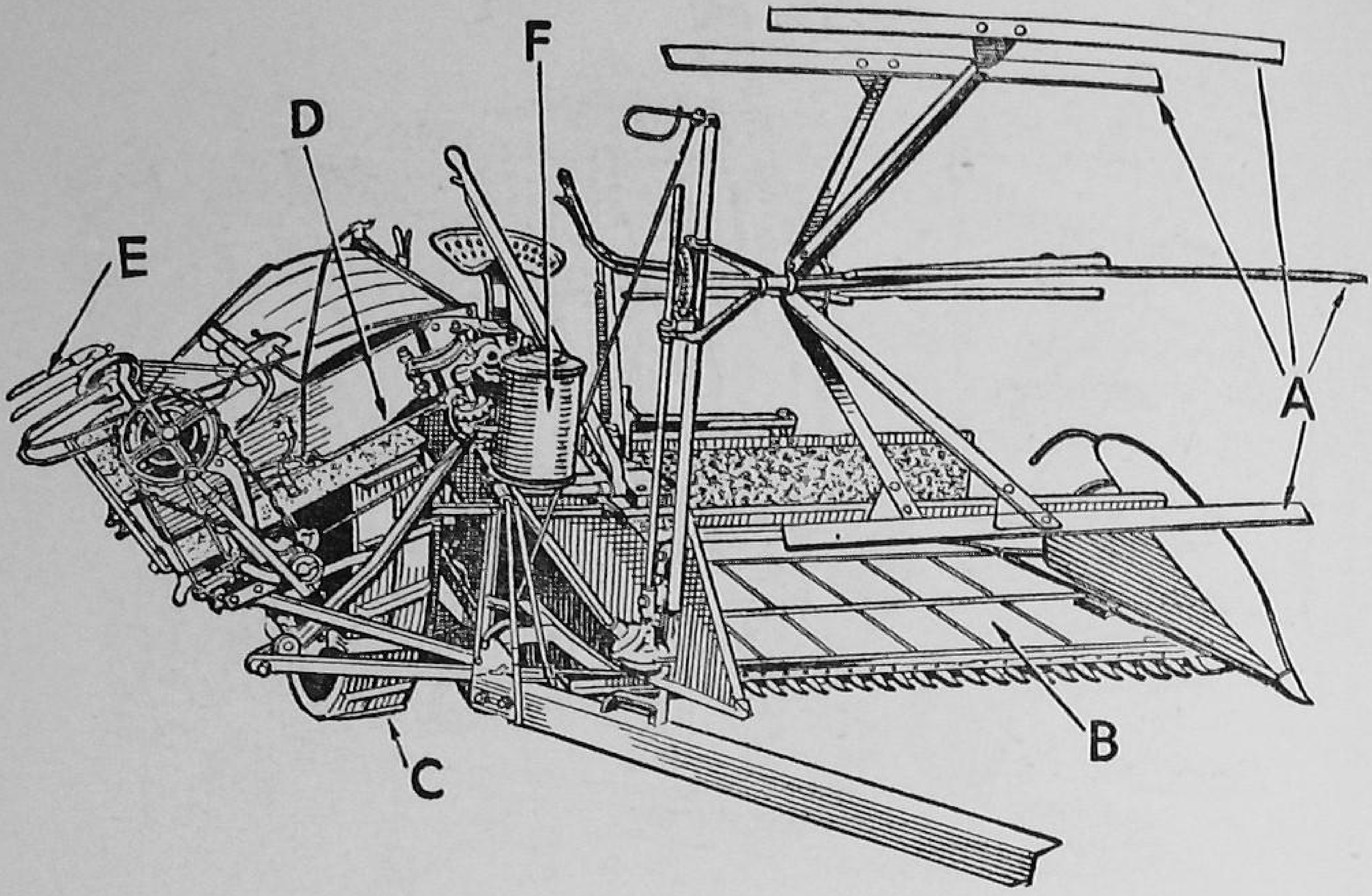
Elevator.

Whatever method is used to get the hay to the site of the rick, some form of mechanical elevator is needed to get the load quickly on to the rick. The most usual machine for doing this is the endless-belt elevator.

The moving belt, made up of chain with cross slats studded with hooks is in a long, narrow inclined trough. At first, elevators of this kind were driven by a horse motor. The horse walked round and round, harnessed to the end of a pole. The other end of this pole was fastened to a gear-wheel which transmitted the energy to a rotating shaft connected with the endless-belt mechanism of the elevator. The horse motor has now been replaced by a small petrol engine.

Fork-and-Pulley.

The other way of lifting the hay on to the rick is by some form of grapple fork and pulley tackle. A portable jib, supported on shear legs, is erected alongside the rick, and a horse, harnessed to the



A REAPER-BINDER

The cut grain is swept by the sails, A, on to a moving canvas platform, B, which carries it sideways to deposit it on to another, elevating, canvas. This second canvas carries the corn over the bull wheel, C, on to the top of a sloping deck, D. The corn slides down this deck and on to a length of twine stretched out ready to receive it. Swinging packer arms compress the bundle of corn into a sheaf. When a large enough sheaf has been formed, a trip mechanism sets the twine-binding mechanism into action. The needle, holding the twine, rises from below the sheaf and moves forward, carrying the twine with it to encircle the sheaf and meet the twine on the other side. At the junction the twine is tied by the knotter bill. Then the discharge arms, E, come into action and throw the bound sheaf off the deck on to the ground. At the same time the twine is cut automatically by a knife, near the knotter bill, but in such a place that the knotter retains one end of the twine ready to encircle the next sheaf to be made. The twine is fed from a ball in the can, F.

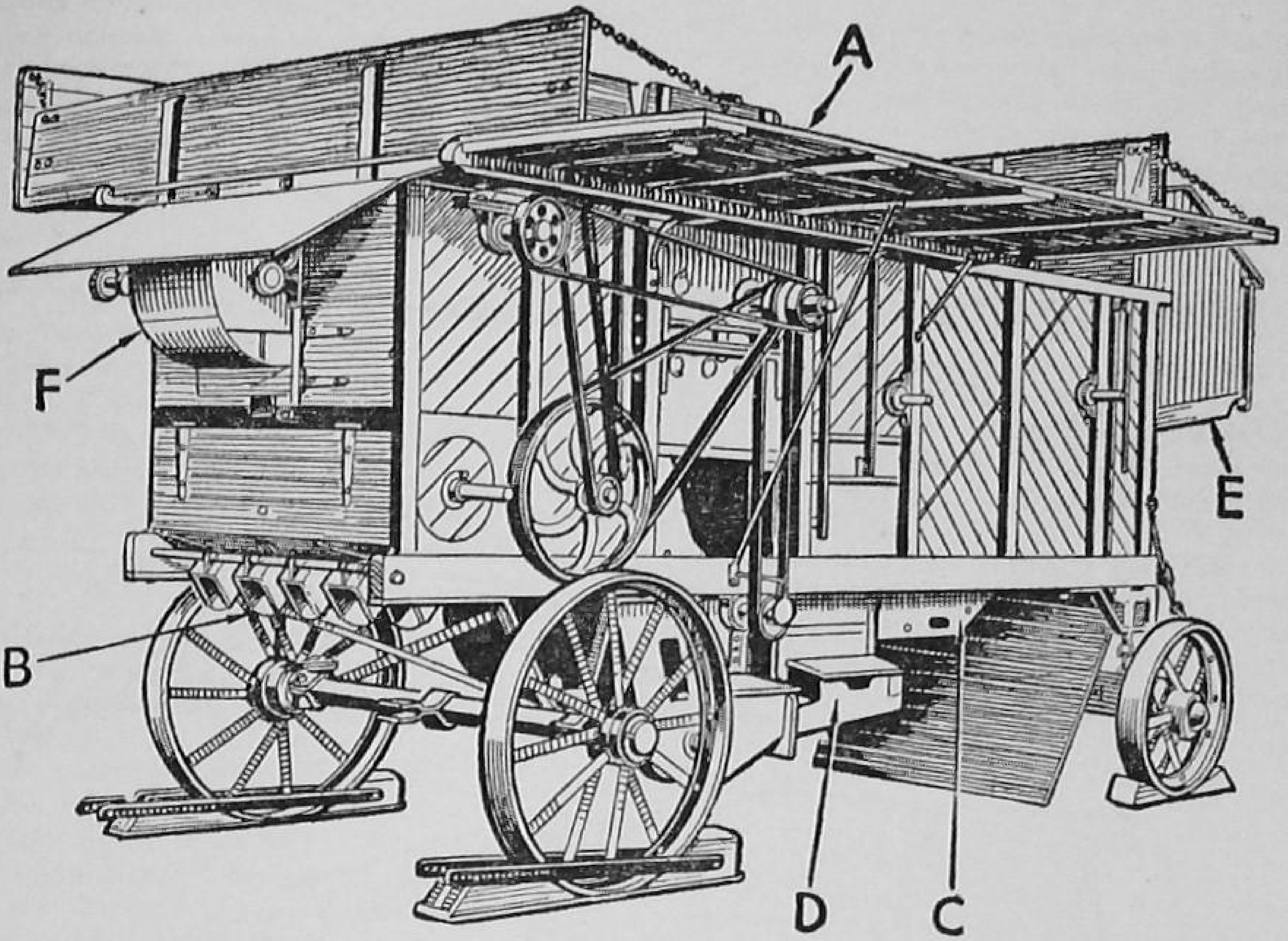
In all horse-drawn binders, and in some tractor-drawn ones, the drive is taken from the bull-wheel; but on some models the mechanism is instead driven by power take-off shaft from the tractor towing the binder. This is a great advantage when the field is damp and the bull-wheel might have insufficient grip on the ground.

rope or cable, lifts the fork-load of hay by walking away from the jib. Here again the horse is now being replaced by a petrol engine which drives a winch; the loading is controlled by a clutch and brake on the winch.

Silage.

On some farms, some of the grass is not left to go on growing to the stage at which it is ready to be cut for hay, but is cut while the grass is still in its young, more nutritious state, and is preserved either by drying it artificially or by controlling its decomposition so that it shall form that very good feed for milking cattle, called silage. Silage is made either in a brick or wooden silo, usually built in the shape of a cylinder, or in a stack or pit. The fermentation of the green stuff is controlled by the way the material is packed into the silo since this determines how much air can get to it, and by the addition of either a mineral acid or molasses. The object of these additions is to prevent butyric acid fermentation. The mineral acid does this directly; the molasses does it by forming lactic acid by its own fermentation.

The young grass can be cut quite satisfactorily by an ordinary mowing machine; but the cut short grass is difficult to collect easily. When it is thrown as swaths onto the ground it lies very close and firm, and its dampness and the shortness of its stems defeat most types of ordinary hay-sweep and wagon pick-up loader. Some types will do it, and special modifications of these are made for short grass work. One combination machine is a mower and collector all in one. It does not let the cut grass fall from the mower



A THRESHING MACHINE

The sheaves of corn, when their bands have been cut, are fed into the mouth of the drum-box, A. The threshed grain comes out of spouts B. Chaff and dust come out at C, and small weed seeds at D. The straw, carried through the machine by shakers, comes out under the canopy, E. F is the housing of one of the air-blowers. The threshing is carried out in general stages, although all the stages go on automatically and all are completed inside the one machine. The first stage is the knocking of the grain out of the ears. This is done by the bars on the revolving drum which beat the corn against the concave grid. The straw is shaken to remove any further grain and chaff that may be in it, then the straw passes out of the machine. The grain and the chaff and the seeds from any weeds that may have been in the crop, are subjected to a powerful air blast to winnow the chaff away from the grain and weed seeds. Next the grain is separated from the weed seeds, by riddles. The grain then receives a further dressing, or cleaning, to clear away any husks that may be left. Riddles, and an air blast from a fan, are used in this dressing. Sometimes the grain is delivered at the outlet spout in this condition, but often it is lead into a rotary sieve which divides it up into three sizes: first-grade corn, second-grade corn, and tail corn.

on the ground at all, but elevates it straight from behind the cutter bar onto a wagon.

The mechanization of corn harvesting also was tackled in the beginning of last century. It was a bigger problem than that of the hay harvest and has given us more complicated machines.

Reaper-Binder.

The first stage in adapting the grass mower to deliver cut grain in a form convenient for the harvest workers to tie into sheaves, was to fit on to the mower a reaping attachment which would cause the cut grain to be left not in a continuous swath but in neat bunches. The stems in these bunches must all lie in the same direction, that is to say, all the ears of corn must be at one end of the bunch so that all that remains to be done to make up the sheaf is to tie a straw round the middle of the bunch. The reaper was made successfully and was a great advance, but inventors were seeking for a method of tying up the bundle automatically while it was still in the machine. They found a method, and the self-binder, or reaper-binder, although it looks an awkward and complicated machine, is probably the most ingenious machine farming has ever gained or is likely to gain.

The first essential difference between the binder and the mower is that a rotating reel, or series of sails, directs the standing, uncut corn on to the cutting platform so that when it is severed it is all lying in one direction. The cut corn falls on to a moving canvas belt which carries it sideways on to another moving canvas which elevates it over the big driving wheel of the machine and deposits it on to the top of a sloping deck. The corn slides down this deck until it rests on a projecting arm,

called the compressor arm. Three other arms, called packer arms, moving on a crank, compress the corn against the compressor arm. When the bundle of corn compressed against the compressor arm has been built up to a certain, predetermined size, the compressor arm gives way and moves a trip lever which sets into motion the binding mechanism. The twine which was already lying stretched alongside and below the compressor arm is now carried round over the top of the bundle to meet the twine on the other side. The knotter bill ties a knot at the junction. Then three arms, swinging on a shaft, sweep the bound sheaf off the deck on to the ground, and at the same time a knife cuts the twine near the knot.

The sheaves are picked up by men and arranged in stooks so that air can get to them and dry them. When they are dry enough they are carted away to the stack. This picking up and carting is a part of harvesting which has not yet been quite fully mechanized. Usually the sheaves are pitchforked on to wagons by hand. Sometimes haysweeps, or a special stook loader, are used to pick them up and carry them, but unless it is done very carefully some of the grain is shaken out of the drying ears and lost.

Corn Stack.

The same elevator as is used in building hayricks can be used to build the corn stack. When the stack is made it has to be thatched to protect the corn from rain. In the stack the corn goes on drying, and it can safely be left for several months before it is threshed, though the trouble from rats is usually so serious that the farmer is anxious to get the corn threshed and the grain sold just as soon as possible.

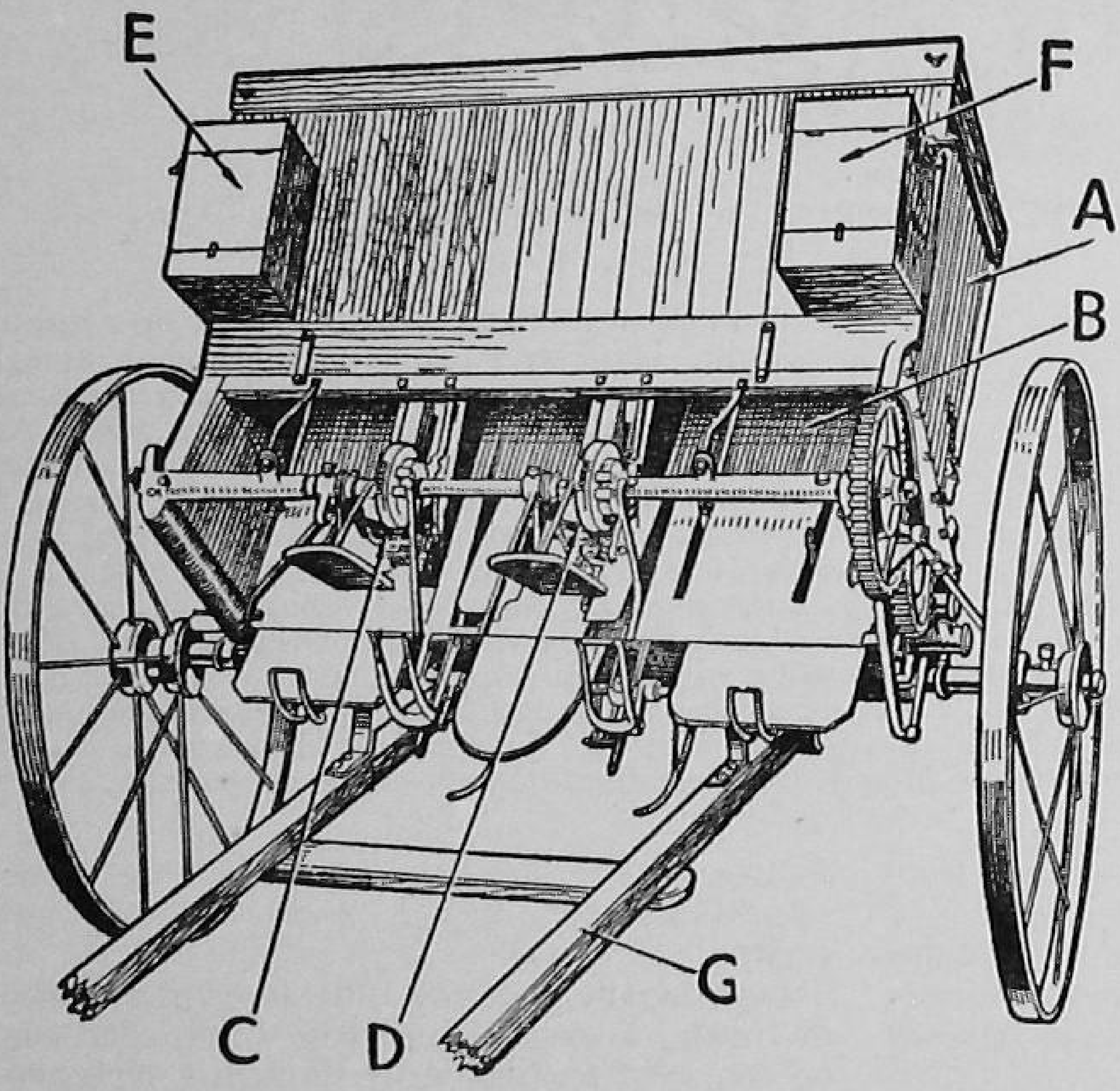
Threshing Machine.

The threshing machine is essentially a cylindrical assembly of beater bars which rotate very near a concave grid which partly encircles the cylinder. The corn is fed into the space between the beater bars and the concave grid. The width of this space has to be adjusted according to the kind of crop being threshed, that is to say according to whether it is wheat or barley or oats, and also according to the moisture condition of the corn.

Besides the actual threshing cylinder, called also the drum, the threshing box contains screens and air blowers which complete the separation of the grain from the chaff and from small weed seeds which were gathered with the crop. The straw passes along a shaker platform, a kind of elevator in which a reciprocating motion is used to work the straw upwards towards the outlet of the machine. The straw is conserved for use as bedding in cattle stalls and for thatching, and usually it is baled or trussed as it leaves the machine.

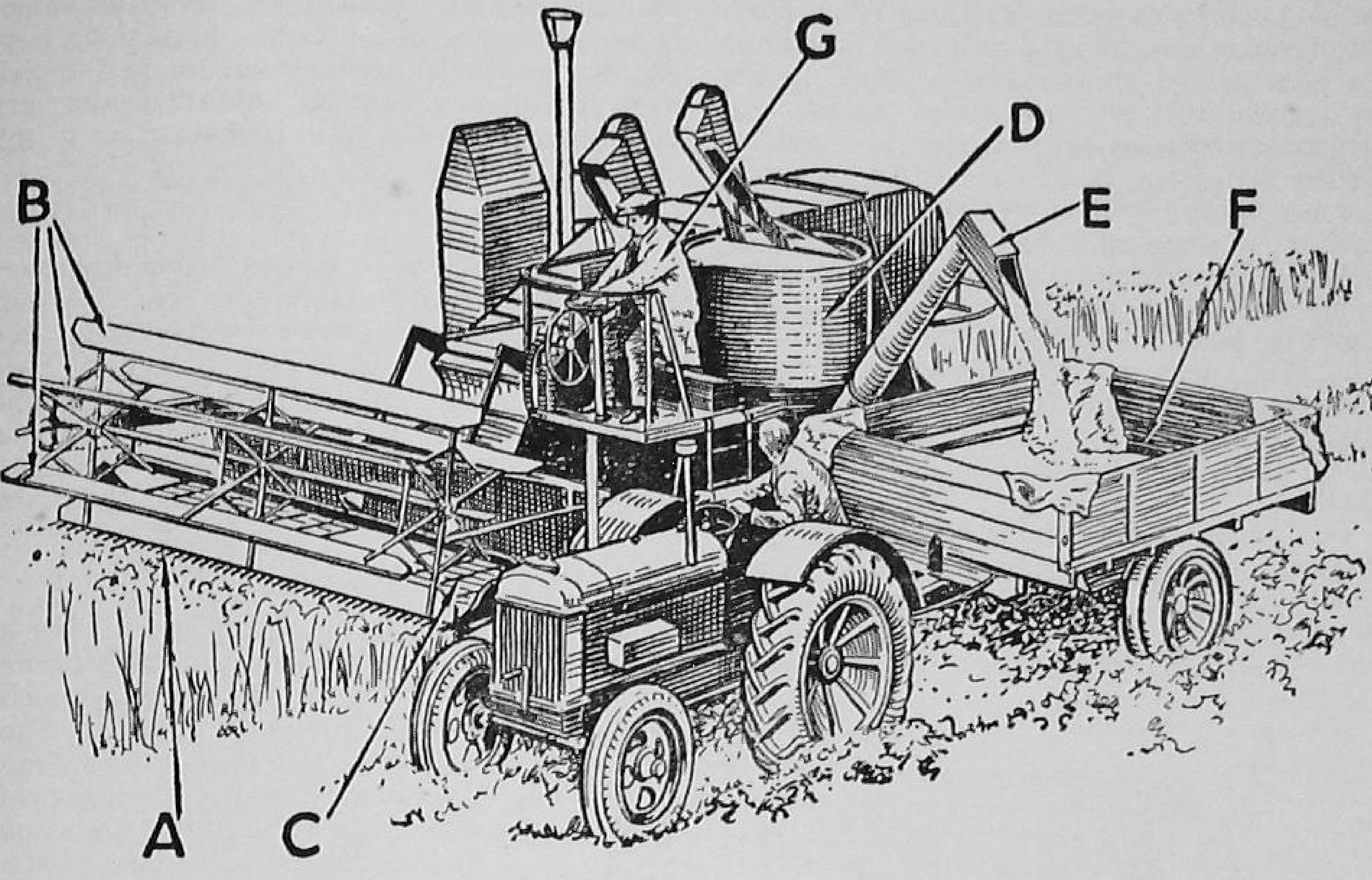
Trusser.

The trusser is a machine very much like the bundling and tying mechanism of a reaper-binder. It uses twine to tie the trusses. Such a machine cannot compress the straw tightly, and if the straw is going to be sent off the farm, or if storage space is short, a high compression, wire-tying baler is used. The baler has a heavy reciprocating ram piston which compresses the straw against a



A STRAW-TRUSSER

This machine is an accessory to the threshing machine. It is backed against the thresher so that the straw leaving the strawboard at the end of the threshing box falls into the hopper, A. From this hopper it slides down the binding deck, B, upon which it is bunched and then tied up by a needle-knotter, very much like the knotter of a reaper binder. Two bands of twine are put round each truss of straw in this machine, therefore two sets of knotting mechanisms, C and D, are used, and two holders for balls of twine, E and F. The released trusses slide down the shafts, G. The trusser is driven by chain from a sprocket on one of the shafts of the thresher, so that one tractor, or steam-traction engine, can drive both thresher and trusser. Ordinary binder twine is used in the trusser.



A SELF-PROPELLED COMBINE HARVESTER DISCHARGING GRAIN INTO A TRACTOR-DRAWN TRAILER

The cutter bar, A, and the sails, B, and the first conveyor canvas, C, are much the same as they are on a reaper-binder. But the elevator takes the corn into a threshing drum. The threshed grain, after travelling through cleaners, is elevated so that it can flow into the bin, D. When this bin is full, another elevator can be set into motion to discharge the grain through the pipe, E, into a trailer, F, being towed alongside the combine. An engine on the combine drives all its cutting and threshing and elevating mechanism and also drives the whole machine forward. The driver, G, can control all the mechanism and also steer the course. The steering is accomplished through twin tiller-wheels at the rear of the machine. The straw and chaff are discharged on to the ground behind the combine.

In self-propelled machines like the one illustrated, everything possible is done to relieve the physical strain on the driver so that he can give full attention to his complex job of looking after so many different processes at once. An example of this is the thought that has been put into the mechanism for raising and lowering the front assembly which contains the cutter-bar and sails. This mechanism has to be used to adjust the height at which the corn is cut, as well as to lift the bar right out of work for transport. On some combines a spring-loaded lifting-arm is used to ease the work, on others the lifting is done hydraulically, while on others an electric motor is employed.

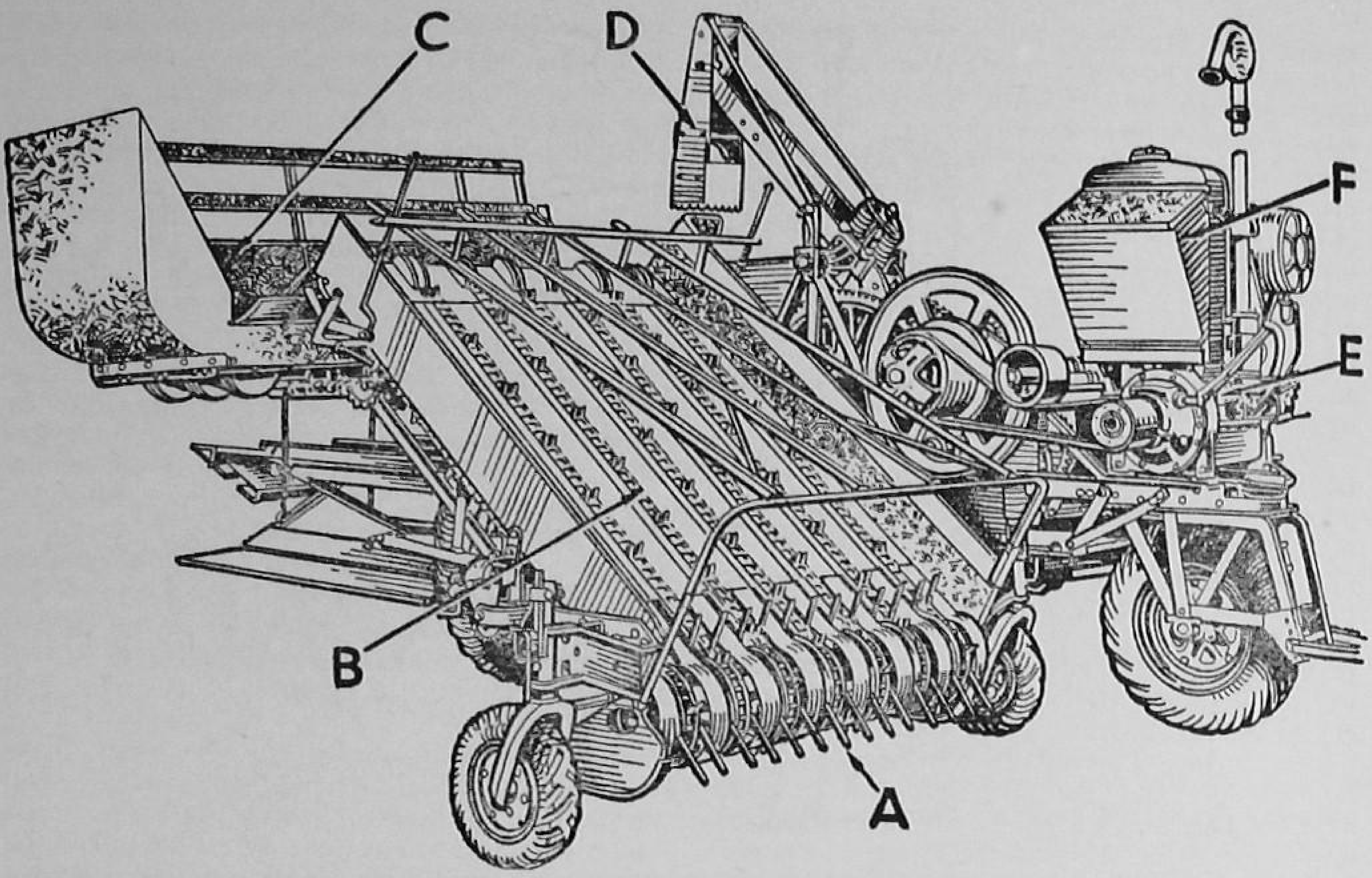
buttor board in a rectangular chamber. When the bale is sufficiently large and at a sufficient compaction, it is tied round with two strands of wire.

Straw which is going to be used for thatching must not be baled, because the strands become bent and broken. Trussing does not damage the straw.

A full-sized threshing machine, with a drum of 4 feet 6 inches in length, needs about 20 horse-power to drive it. Usually a high-powered tractor is used to haul the machine to the stack and then to drive its mechanism, and such a tractor has power enough to drive, at the same time, the trusser or baler, and any other machines such as the elevator for lifting the sheaves to the feeding mouth of the drum.

Chaff.

Occasionally the straw, instead of being baled or trussed, is cut up into chaff. This chaff can be conveyed pneumatically through a pipe into the barn where it is to be stored. Another way of dealing with the straw is just to rebuild it into a stack. An ordinary elevator can be placed with its receiving trough at the straw delivery outlet of the threshing box. In America the straw is often elevated from the thresher on to the rick pneumatically; but this method is more satisfactory with bruised, broken straw than it is with the whole stems delivered from a British thresher. Unbroken straw is apt to lodge across the pipe and cause a blockage. But in America the usual kind of thresher is a little different in type from ours. The cylinder, instead of having



A PICK-UP BALER

The rotating prongs, A, pick up the straw or hay from the ground and deposit it on to the elevator chains, B. The pegs on these chains carry the straw or hay upwards into the hopper, C. The bottom of this hopper is an endless belt conveyor which urges the straw or hay towards the baling chamber, into which it is pushed by the reciprocating plunger, D, called, from its shape and action, the " horse's head." The mechanism is driven by the engine, E. This engine is water-cooled, and the radiator, F, has to be screened carefully to prevent bits of straw being drawn between its fins and reducing its cooling capacity.

Some pick-up balers use thick twine instead of wire to bind the bales. Twine-tying balers can more easily be made automatic in operation than can wire-tying ones, because the twine can be tied by a needle and knotter-bill of the kind used on a reaper-binder. Wire thick enough for baling purposes cannot be tied in a device of that kind.

It would be well if all balers, stationary and pick-up, used for straw or hay for cattle, could be of the twine-tying sort. When bales come to be unbound for the straw or hay to be used, the wire is often left where cattle can pick it up and swallow it with their food. Many cows die each year from this cause. Twine is far less harmful.

beater bars or rubbers, is studded with steel pegs. These pegs pass between other pegs fastened to the concave grid. Peg drums use less power than beater drums, and they are not as sensitive to uneven feeding of the sheaves into the box, and they give a very clean sample of grain. Their chief disadvantage is that they break the straw and so spoil it for thatching. For every other purpose for which straw is used, this bruising does not matter at all. For cattle bedding, bruised straw is better because it can absorb liquid manure more readily.

We have seen that in the first part of last century, inventors were working hard to find a way of automatically producing tied-up sheaves. Towards the end of the century people were beginning to wonder whether it was worth while to bind up the corn into sheaves at all and stack it and then take the stack to pieces and thresh the corn. They sought to make a machine which would cut and thresh the crop all in one operation.

Combine-Harvester.

Whether the first successful combine-harvester was made in Australia or in America is uncertain. The Australians concentrated on devising a header or stripper machine which would cut off, or comb off, just the ears of the corn and leave the straw standing. The Americans kept to the principle of cutting the corn near the ground, as a binder does, and having a threshing drum of large enough capacity to deal with the whole length of straw.

It is said that the demand for the quick development of the combine-harvester in America came more from the wives of the farmers than from the farmers themselves. American farmers never have kept all-the-year-round staffs of hired workers. Most farms are worked by the family

themselves. Stooking and carrying the grain harvest was, however, more than the family could manage, and for this labour the farmer relied on bands of mobile workers who travelled through the grain country, moving from places of early harvest, northwards towards the places of late harvest. These bands of workers lived in the farmhouse during their stay, and the farmer's wife had to feed them and look after them. She did not like this scheme, and the prospect of a machine which the family themselves could work and which would turn out grain all ready to sell straight from the harvest field had a great appeal.

The first machines to be manufactured and taken over the Rockies to the wide, dry wheat prairies were huge machines with a cutting width of 14, 16 and even 24 feet. They were towed at their work by teams of as many as thirty horses or mules. The cutting, elevating, and threshing mechanisms were all driven from the land wheels of the machine. Later on, steam traction engines were used to tow the combines. Then a petrol engine was mounted on the combine to drive the mechanism. This cut down the draught of the machine so that a medium sized tractor could haul it comfortably. Finally some large machines were made to be self-propelled; the engine was made big enough to drive the land wheels as well. Alongside the development of these prairie combines, work was being done to produce a satisfactory small combine which would take the place of the 4 feet 6 inches reaper-binder on the small mixed farm. This work was helped by the improvement in power-take-off drives on medium sized tractors. Instead of having a separate engine to drive the reaping and threshing mechanism, or relying upon the grip of the land wheels to transmit power, the tractor was able to drive the mechanism directly through a universally jointed shaft. This was much better, because wheel grip is uncertain when the machine is as light as these small combines were to be, and when the power to be transmitted has to be sufficient to drive a whole threshing unit as well as the cutter.

These combines are quickly replacing the binder on American farms, and would just as quickly replace the binders in Britain except for one unfortunate circumstance. In nearly every part of America the grain cut and threshed from a field of ripe corn is dry enough to be stored or carried in bulk. In the damper climate of Britain this cannot be relied upon. In a wet season, the corn may be quite ripe enough to cut and thresh but the grains may still contain so much moisture that they will ferment and heat if the corn is left in bulk. Therefore, the grain has to be dried artificially after it has been threshed. Thus, unless the farmer can be sure that he will be able to cart the combined grain away at once to some mill or factory which has a drier, he has to instal a grain-drier at the same time as he buys a combine harvester. Grain-driers are expensive, and one of small capacity costs proportionally more than one of large capacity. Therefore, the use of small combines is not spreading rapidly in this country; most of the machines now being bought are 10 or 12 foot cut, and many of them are self-propelled. The advantages of the self-propelled machine are many; the machine becomes a one-man outfit, and a tractor is saved at a time when it can well be used for pulling wagons to take away the threshed grain. Moreover, all self-propelled machines have the cutter-bar in front, so that the combine can be driven straight into a standing crop. This cannot be done when the machine is being drawn by horses or tractor which would trample or flatten the crop, the cutter-bar has to be at the side, and a way has to be cut round the field by scythe to make room for the horses or tractor before the combine can start work. This necessity for cutting a way, which applies also to the binder, matters more in the compact fields of Britain than it does in the prairies of America and Australia.

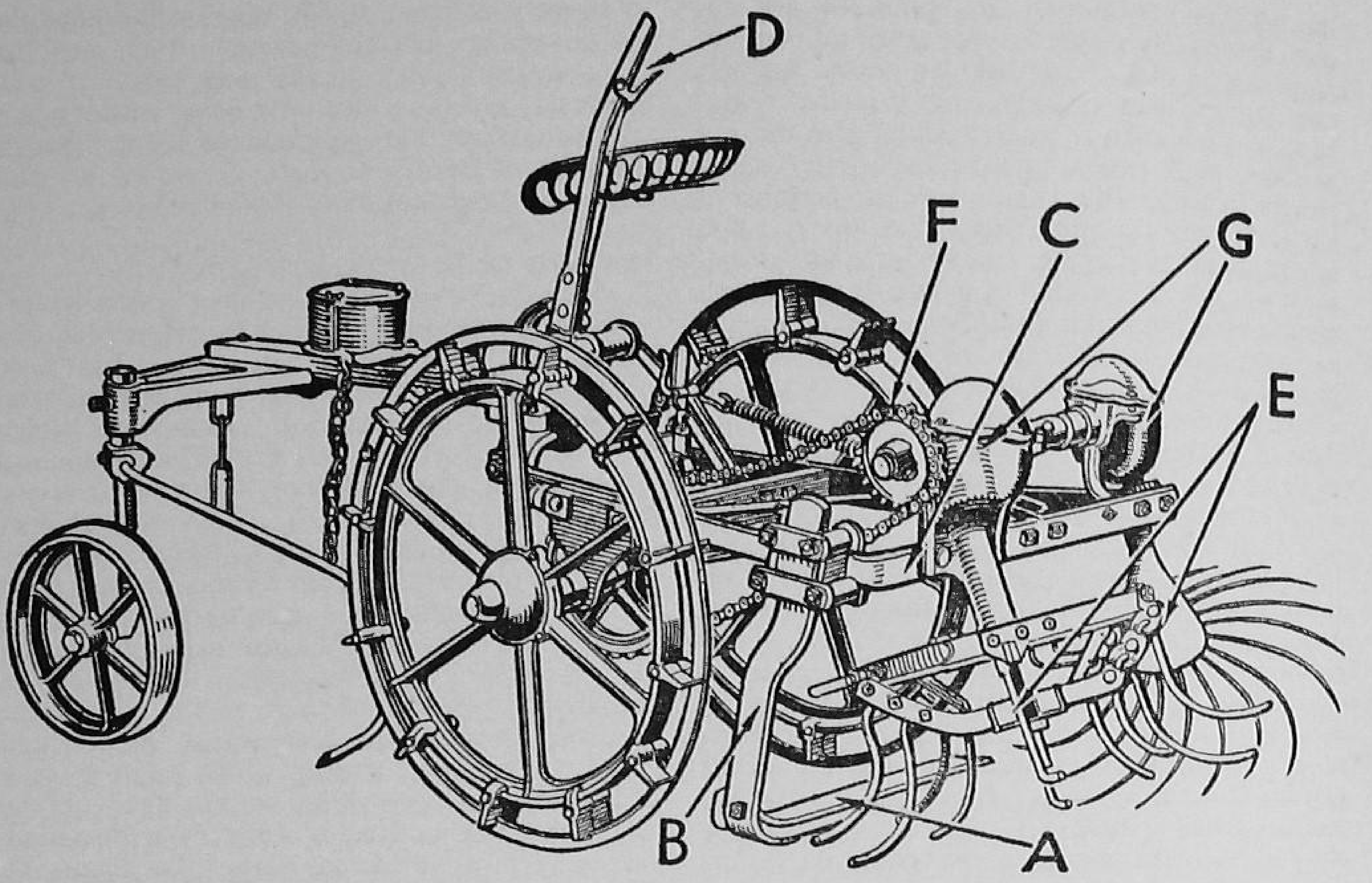
On some combines the threshed grain flows into bags which are dropped on to the field when they are full; on others it flows into a bin mounted on the side of the machine. When the bin on the combine is full it is discharged into bins on wagons or motor lorries, and with skilled drivers this transfer of the grain can be managed without stopping the combine.

Many combines have peg drums, not beater drums. Therefore the straw is bruised. It is spread on to the field, in a kind of windrow, behind the combine. Often it is left to be ploughed into the ground as manure when the stubble is ploughed. Sometimes it is collected on hay-sweeps and taken to a stationary baler, and on large, very highly mechanized farms, pick-up balers are used which are themselves combine machines, for they are a hay-loader and a baler in one.

In passing it may be said that these pick-up balers have also another use, the making of baled hay. Hay can be baled in a greener and more nutritious condition than it can safely be built into a rick. Fermentation and heating do not take place as readily, and the bales can be stored with air-spaces between them. More and more hay is being made this way, either in combine pick-up balers, or in stationary balers fed by a hay-sweep.

Grain-Driers.

Grain-driers are constructed to blow hot air, or hot products of combustion, through or over the grain. In some types a slatted conveyor slowly carries a layer of grain through the drier. In others, the grain is elevated and then allowed to fall through a heated tower. The fuel used in driers is generally coke, though oil and coal gas have also been used. The grain being dried moves slowly but continuously through



POTATO SPINNER

A is the share which passes under the potatoes and loosens the soil around them. This share is bolted to the upright stem, B, which at its other end is clamped to the frame, C. The frame, C, which carries also the two sets of spinner marked E, can pivot about the axle of the machine. The position of the frame is controlled by the handle, D. Therefore the handle, D, within easy reach of the operator sitting on the seat, controls the depth and pitch of the share; and any movement of the handle changes at the same time the position of the spinners so that they will correctly follow the share. The drive to the spinners is taken through the chain, F, which is on a sprocket mounted directly on the main axle of the machine, so that the land-wheels cause it to rotate. In the boxes marked G are bevel gears which turn the drive through a right-angle so that it shall rotate the spindles to which the spinners are attached. The tension of the chain remains constant whatever the angle at which the frame C is tilted, because the centre of the driving sprocket wheel lies on the pivot line of the frame. In the particular model illustrated here, the prongs of the main set of spinners which throw out the loosened potatoes to one side of the implement, are fastened rigidly to radial arms on an inclined spindle. The second spinner, alonside the main spinner, checks the potatoes from being thrown too far away from the machine, and also it knocks off some of the soil that may still be sticking to them. On other kinds of potato diggers, having only one spinner, a vertical screen is used to prevent the potatoes being scattered too far from the implement. On many potato spinners, the prongs are not fixed directly to the spindle, they are mounted on links which connect two concentric reels. The link motion, much the same as that on a swath-turner, is arranged so that the prongs remain vertical as they enter the soil and pass through it.

the apparatus. Temperatures of the hot gases and of the grain itself have to be controlled rigidly, because if the grain gets too hot its property of germination is destroyed and it becomes no good for seed, and indeed it is possible for its milling quality also to be harmed. As soon as the grain is dry enough it must at once be cooled by blowing cold air through it.

Root Crops and Potatoes.

The harvesting of root crops and potatoes can take even more labour than the harvesting of grain, but the season in which it is possible to do it is longer. Nevertheless, the gathering in of potatoes and sugar beet produces a serious enough peak labour demand to deter many farmers from growing these crops at all, and it is these harvest problems which are at present engaging much of the attention of agricultural engineers.

For many years potatoes have been dug out of the ground by a machine called the spinner. In the front of the machine is a share that runs right under the potatoes and loosens them and the soil around them. Behind this share comes swinging rods which have very much the same kind of motion as have the spring-loaded tines of a hay swath turner. The spinning rods throw the potatoes, and some of the soil, to the side of

the machine. Although the potatoes are not quite completely separated from the soil they are fairly easy to pick up, and skilled potato workers can gather them quickly and put them into baskets. But each spinner machine can dig out potatoes at a rate which needs about twenty pickers to gather the potatoes; and therefore it has been clear for some years that any increase in the speed of digging was of little use unless some way could be found of partly or completely mechanizing the picking up. For more complete harvesters the spinner principle was abandoned. Instead a wide, shovel-shaped share was used to dig the potatoes and to direct them on to the lower slats of a chain elevator band. The potatoes move up this band, and because the band is only a framework, made up of slats and chain, much of the soil falls through it back on to the ground. From the top of the elevator the potatoes fall on to a shaker which throws off more soil while oscillating forks pick off the haulm. The potatoes, nearly free from soil and bine, can be directed to fall from this shaker on to the ground in a compact narrow row which provides a much easier job for the pickers than does the haphazard placing from a spinner. But to complete the mechanization and to make a machine comparable with the combine grain harvester, it is necessary to add a device for bagging the potatoes or elevating them on to a cart, straight from the shaker, instead of letting them fall on to the ground to be collected up again and carried away. The last part of the operation has proved to be very difficult, chiefly because the potatoes are not really sufficiently clean and dry and free from mixture with stones and clods of soil. However, machines are now being made which will completely harvest potatoes from some of the soils of Britain, though sticky soils are still defeating the inventors of these machines.

Harvester for Sugar Beet.

Much the same difficulties have beset attempts to make a complete harvester for sugar beet, and much the same degree of success has been obtained. Harvesters which were designed and made on the continent of Europe, and which have worked perfectly well in the climate and soil of some of the sugar-beet growing districts, simply will not work at all in our stickier conditions. Much hard thought and experiment is being put into the problem and, indeed, there are now machines which do work well in at least some of our conditions. These machines, having cut off the tops of the beet while they are still in the ground, dispose of them to the side of the machine, then lift the beet out of the soil and place it upon an elevator which takes it to a convenient delivery point at the rear of the machine. The cutting is done by a disc-knife revolving in a horizontal plane; the digging is done by shares which are arranged at such a depth as not to injure the beets. At one point in its journey the sugar-beet is agitated so that most of the soil adhering to it is knocked off and falls through the elevator back on to the ground.

MACHINES FOR CHEMICALS

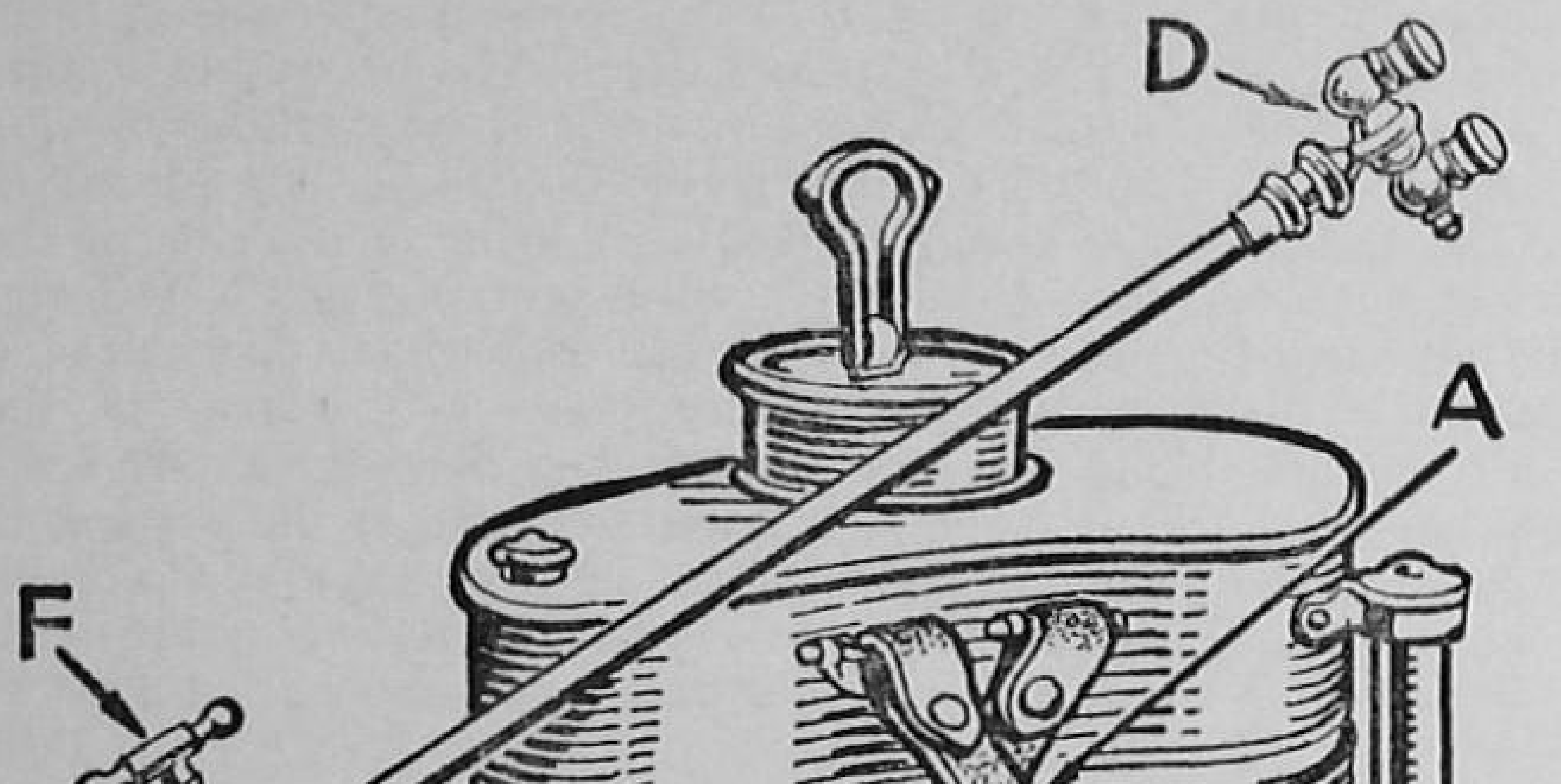
Our author deals in this brief section with the implements used to apply chemicals both in liquid form and powder form. It is a wide range of machines that is used for such operations as spraying and dusting and the principles involved are clearly set out. The treatment of seed corn to protect it from seed-borne diseases is explained.

To Protect Plants.

VARIOUS chemicals, both in liquid form and powder form, are used to protect plants against pests and fungous diseases which would depress the yield of crop, to kill weeds which would compete with the crop plants for sun and plant food, to shrivel up green stuff, such as the haulm of potato, which would interfere with easy harvesting, and to preserve cattle foods such as silage by controlling decompostion. The machines for applying these chemicals have come to be a regular item of farm machinery. They range from simple stirrup-pumps for spraying solutions from buckets on to fruit bushes to aerial aircraft dusters used to spread fungicide powders on to fields and orchards at the rate of 350 acres an hour.

Liquids.

The liquids to be sprayed are often of a nature most difficult to pump and most destructive of the materials generally employed in making tanks and pumps. For example, the Bordeaux mixture sprayed on to potatoes to protect them from attack by the fungous disease, blight, is copper sulphate added to water containing lime, and it does not form a true solution, but only a suspension which needs agitation to keep it homogeneous. Another difficult liquid to deal with is the sulphuric acid solution used for killing charlock and other weeds in corn. Sulphuric acid attacks most metals, and unless the pump is made of some special resistant alloy, the sprayer must be washed out completely immediately each spraying is finished.



A KNAPSACK SPRAYER

This sprayer is carried on the back of the operator and is held there by the straps, A. The pump, B, worked by the handle, C, provides the pressure which ejects the spray fluid through the nozzles at D. The tank, E, is shaped to fit snugly on the operator's back, like a knapsack. The tap, F, controls the rate of ejection of the spray.
Pressures of about 50 pounds per square inch can be reached with a knapsack sprayer, and this is sufficient for applying liquid fungicides and insecticides to plants in market gardens and allotments, and to low trees in orchards.

Sprayers for Liquids.

In some sprayers for liquid the solution is pumped directly; in others air is pumped into the tank containing the fluid, so that when the nozzle is opened the liquid flows out to be replaced by the air. This latter principle is used on some of the Knapsack sprayers employed for treating small fruit trees. The operator carries the tank, of about five gallons capacity, on his back. Convenient to his one hand is a lever for pumping up the air pressure. He need not keep pumping all the time. The built-up air pressure will keep the liquid flowing for some time. On some models the hand-lever also works a rotary paddle for agitating the liquid to keep the solids in suspension.

Larger outfits are mounted on a wheeled frame and the pump is driven by an engine, or through power-take-off from the tractor which is towing the machine through the orchard. These

outfits will work several nozzles at once, and provide a sufficient pressure to force the spray to the top of high fruit trees. The nozzles, which have carefully designed jets to throw the spray of liquid into the most efficient pattern, are built into lances which are held by the operator. The lances have taps for controlling the volume of the flow and the shape of the spray. In these machines the liquid is usually pumped directly by a multi-cylinder piston pump or a centrifugal pump. Pressures as high as 400 lb. per square inch are attained, and, indeed, are necessary to put a full cover of liquid on to tall trees.

Spraying Potatoes.

For spraying potato haulms and corn-fields a cart sprayer is used. A large wooden barrel contains the liquid which is forced into a transverse pipe along which are jets directed towards the ground. The pump is driven either from the land-wheels of the cart, or by a small petrol engine mounted alongside the barrel.

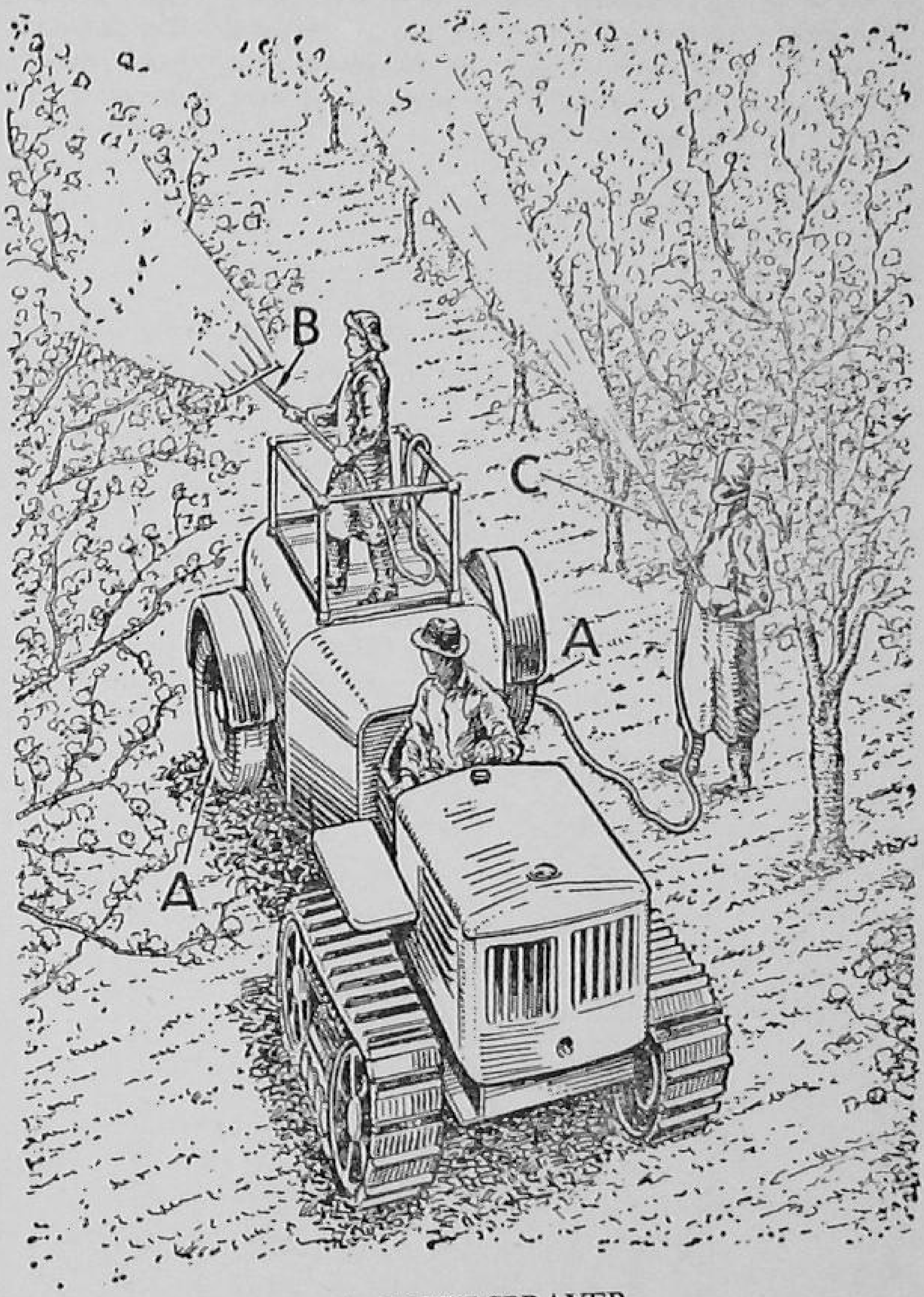
Powder.

One of the reasons why some crops are treated with a fine cloud of powder fungicide or weed killer instead of with solutions is to avoid the heavy carting of water necessary if the solution of mixture is to be made dilute enough for the active material to be spread evenly over large areas.

Blowers.

Powders can be blown in a fine dust either from a hand-operated box in which a small bellows provides the draught; or from a horse-drawn, or tractor-drawn, cart in which the bellows or fan is driven from the land-wheels; or from aircraft in which part of the blast of air from the screw is conducted through a venturi tube to discharge the powder. Some tractor-mounted blowers use the stream of exhaust gases from the engine to impart movement to the powder.

For successful operation of the blower, and for adequate covering of the crop, the powder must be in a very finely-divided condition. Most of the powders used are unpleasant and rather dangerous to handle. Some contain cyanide and some arsenic.



A FRUIT-SPRAYER

The pump and the tank of spray fluid are mounted on the wheels, A. The pump is driven through a power take-off shaft from the tractor. The boom, B, being used by the man on the platform, has several jets and is giving a wide spray; the lance being used by the other man has a single jet for projecting a narrow cone of spray to a greater height. The operators wear special clothing to protect them from the spray.

On some machines, additional platforms are provided, some of them mounted on high towers, so that as many as four men, each with a boom or lance, can ride, and operate the sprays while the outfit moves slowly along between the trees. An even more completely mechanized outfit can be used in orchards and hop gardens which have been laid out in designs specially suited to the method. The spray nozzles are attached rigidly to the spraying machine, in various places and pointing at various angles. Only one operator is needed, and all he has to do is to drive the outfit slowly down the lane between the trees or plants and shut off the spray when he reaches the end of the lane, and turn it on again when he drives into the next lane. Such outfits are usually self-propelled, not tractor-drawn, and so the driver is handy to the taps and other controls of the sprayer.

Weed-Killer Powder.

Weed-killer powders can, however, be sown by an ordinary artificial manure distributor if they are bulked with a very large proportion of some fertilizer or other. For example, minute amounts of some of the selective weed killers are mixed intimately with large amounts of lime. The lime serves the same purpose as does the water in a solution, and also is likely to do good on its own account to most kinds of soil.

Seed Corn.

Seed corn is usually dressed with organic mercury salts to protect the plant against bunt and other seed-borne diseases. Most farmers buy their seed ready dressed, or get their own seed dressed at a seedsman's; but with care the job can be done on the farm. The seed has to be very thoroughly mixed with the powder of mercury salt so that every grain shall have a thin coating of the powder. The machines for doing this are usually of the over-and-over barrel type like butter churns.

RECLAIMING WASTE LAND

Here in another short section our author deals with a subject which is perhaps better known from the experiences of recent years than was the case a decade or so ago. The application of mechanized methods to the eradication of unwanted growth on wastes is indicated and the method of working is fully described. The chemical treatment of bracken is explained and other means for its destruction are considered. The stump-jump disc plough and its work are mentioned.

Land in Good Heart.

BEFORE we turn from considering the field implements associated with arable farming to considering the barn and dairy machinery associated with pasture it may be interesting to notice some of the mechanical methods used to bring back old pasture land into good condition or to give it a spell as useful crop-bearing arable land. The tractor has put into our hands a great opportunity for keeping our land in good heart. An example of this is the speed and ease with which a track-laying tractor can be used to clear away unwanted bushes and trees. Bushes can be pulled out by direct traction through chains, and quite large trees can be pulled out by cable and winch. Heavy portable winches, which are towed and driven by tractor and can be anchored into the ground, are needed to look after heavy work of this kind; but much work of a lighter sort can be done by small winches attached directly to the tractor and driven either from the belt pulley or from the power take-off.

Bush-Pullers.

Hitching the cable or chain takes rather a long time, and attempts have been made to find a quicker way of pulling out small trees by the roots. One of the most successful of these bush-pullers consists of a pair of jaws attached to the end of a freely-swinging draught-pole hitched to the tractor drawbar. Two men are needed to work this outfit, one on the tractor and one to steer the jaws. The man steering the jaws walks behind, and by means of a hooked rod directs the puller towards the object he wishes to remove. As soon as the stem of the bush comes within the three-inch aperture of the open jaws, a lever is tripped automatically and the jaws close and grip firmly on to the stem. The tractor has been moving slowly forward during this operation, and as soon as the jaws are shut the forward movement tears out the bush. Then the tractor is reversed, and the jaws automatically open and release the bush.

The Sweep.

When the bushes have been pulled out and left on the field they are collected up into a pile to be burnt. A tractor sweep is sometimes used for this collecting. The sweep, like a very strongly-made hay sweep, is fixed directly to the front of a heavy tractor, in such a way that the tines project forward and lie along the ground. As in collecting hay, the sweep is driven into the bush, or bunch of bushes, and it picks them up. When a sweep load has been collected the tractor sweep is driven to the pile. Then it is reversed and its load is left behind.

Bracken.

From time to time a considerable acreage of land in Britain has been abandoned for agricultural purposes because of the inroads of bracken, a plant which can get a very tenacious hold on some of our more acid soils. Bracken can be destroyed by continued cutting or bruising. It is cut either by an ordinary reciprocating knife-mower or by a special machine having knives which rotate in a horizontal plane. It is bruised by dragging over it iron bars slung by chains from a whipple tree. Sometimes two cuttings or bruisings a year for four years will clear bracken away altogether. The first of the two annual bruisings, or cuttings, is done in the spring, and the second in June, when the fronds are fully unfolded.

Chemical Treatment.

To hasten the destruction of the bracken a chemical treatment along with the mechanical severing has been used on a machine of the rotating knife kind. A solution of sodium chlorate drips on to an absorbent pad which, if it is kept saturated, distributes a film of the solution over each knife at each revolution. The rate of drip is arranged so that about 20 lb. of sodium chlorate is used on each acre.

These methods are all long-term methods, and only if regularly maintained can treatment of this sort have lasting effect. Much bracken infested land has, however, in emergency, been cleared quickly, and sufficiently for the land to bear a useful crop, merely by ploughing-in the bracken and applying lime. Bracken land is, of course, very acid; some of it has a lime requirement of sixteen tons per acre.

"Prairie Buster."

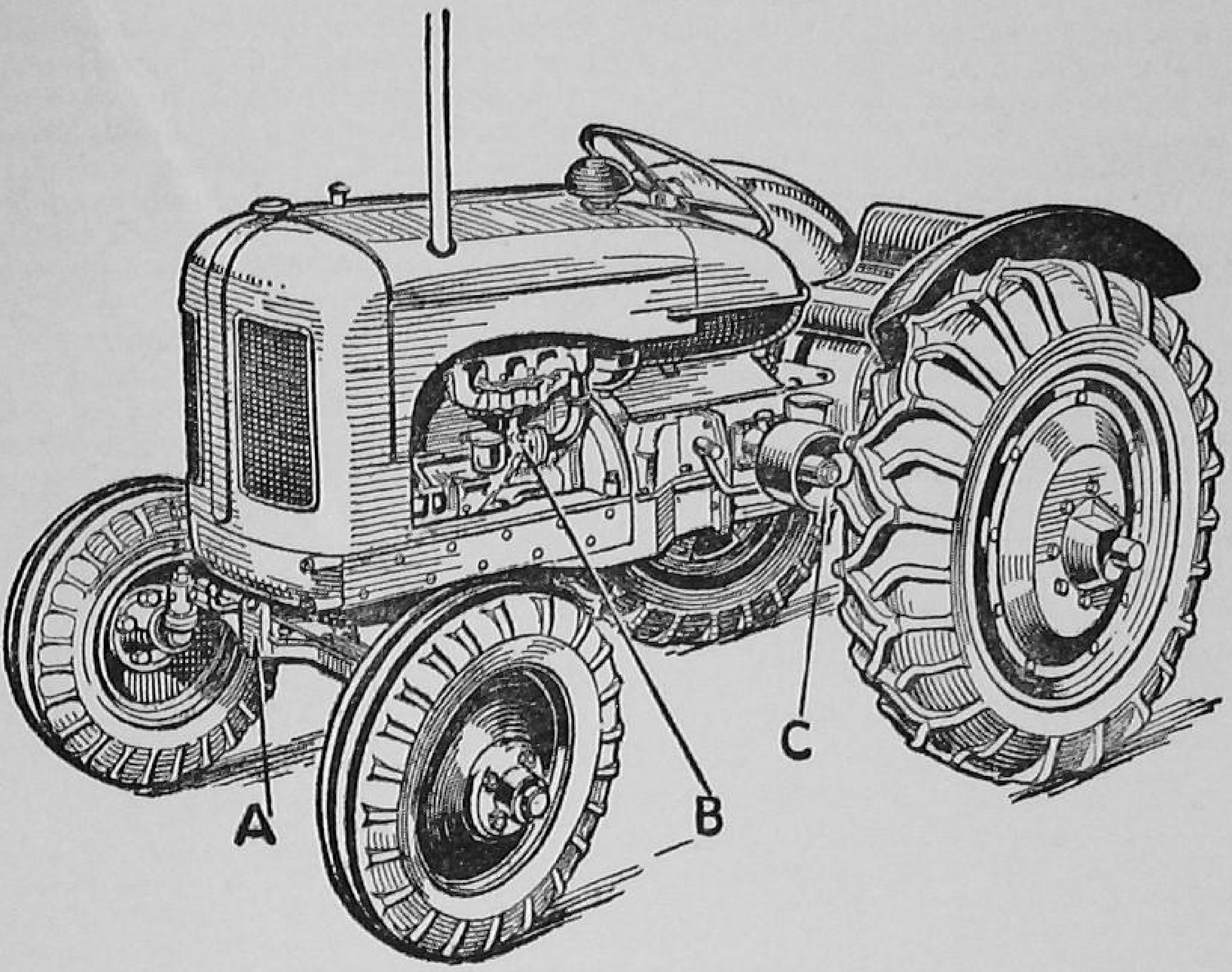
Very large and heavy ploughs are used for ploughing-in bracken and for breaking and burying rank growths of other kinds. Heavy multi-furrow ploughs, with plenty of clearance between the mouldboards to allow room for the rubbish to pass through without choking, can do quite remarkable work in what at first seem impossible conditions. A chain is fitted to each plough body to cut off the long fronds and to help to dig them in. But for dealing with very tall growths it is necessary to use a single-furrow plough, of the type developed in America and called a "Prairie Buster." This plough has very great clearance under the beam, and has a long knife coulter. It will cut a furrow slice 2 feet

7 inches wide and 2 feet deep, and its performance in bringing the soil on to the top of big bushes and luxuriant bracken is quite extraordinary.

Stump-Jump Disc Plough.

Another kind of plough useful in reclamation work is the stump-jump disc plough developed in Australia for bringing into cultivation the arid scrub country. It will tear its way through roots and shrubs. The heavy frame bears down the scrub and the discs slice through the roots of bushes. Some of the under-growth is buried, but most of it is left on the surface and it can be collected up. Each disc—usually there are three of them—is mounted on an independently sprung member so that when a disc meets a stump too thick and too hard to cut through, the disc rides over the stump and is then immediately returned to its work by a strong spring. Meanwhile the other members of the gang of discs have not been disturbed and have gone on working at their usual depth. The awkward stump which resisted the plough can be got out by pick and spade.

The disc of these ploughs is concave, made of steel sharpened on the edge to help it to penetrate the soil and to cut through obstructions. The discs are set at an angle both to the ground and to the furrow wall. This allows the disc to have a scooping action. These ploughs do not make a deep or well-turned furrow, but they certainly are useful for beginning the cultivation of new or tumbled-down land.



A WHEELED TRACTOR

The front axle is pivoted at A, so that the wheels can adapt themselves to uneven ground. This is necessary because the tractor is not mounted on springs which would allow movement to the axles. The vaporizer of the paraffin engine is at B. The belt pulley at C is for the transmission of power for such purposes as driving a threshing machine. Thus the tractor serves also as a stationary engine, and one that can carry itself to its work, and often can tow with it the machine that is going to be used. On many tractors there is also another means of using the power of the engine. This is the power take-off shaft. This drive is used chiefly for transmitting power to the mechanism of implements being towed by the tractor, so that the implements shall not need to rely for their operation upon energy transmitted through their land-wheels. The power take-off method of operation is much used on reaper-binders. The shaft used to carry the power from tractor to implement has a universal joint, so that it can yield to changes in alignment as the outfit travels over uneven ground. The paraffin engine is water-cooled, and the two wire-mesh grids in the panels at the front of the bonnet allow the cooling air to be drawn on to the fins of the radiator. The air flow is induced by a fan mounted behind the radiator and driven by engine. The radiator itself, being behind the cowling of the front of the bonnet, is protected from damage if the tractor should accidentally be run into tree branches or other obstructions. There are two fuel tanks, a large one for paraffin and a small one for petrol for starting the engine, since paraffin is not volatile enough for an engine to be started on it from cold.

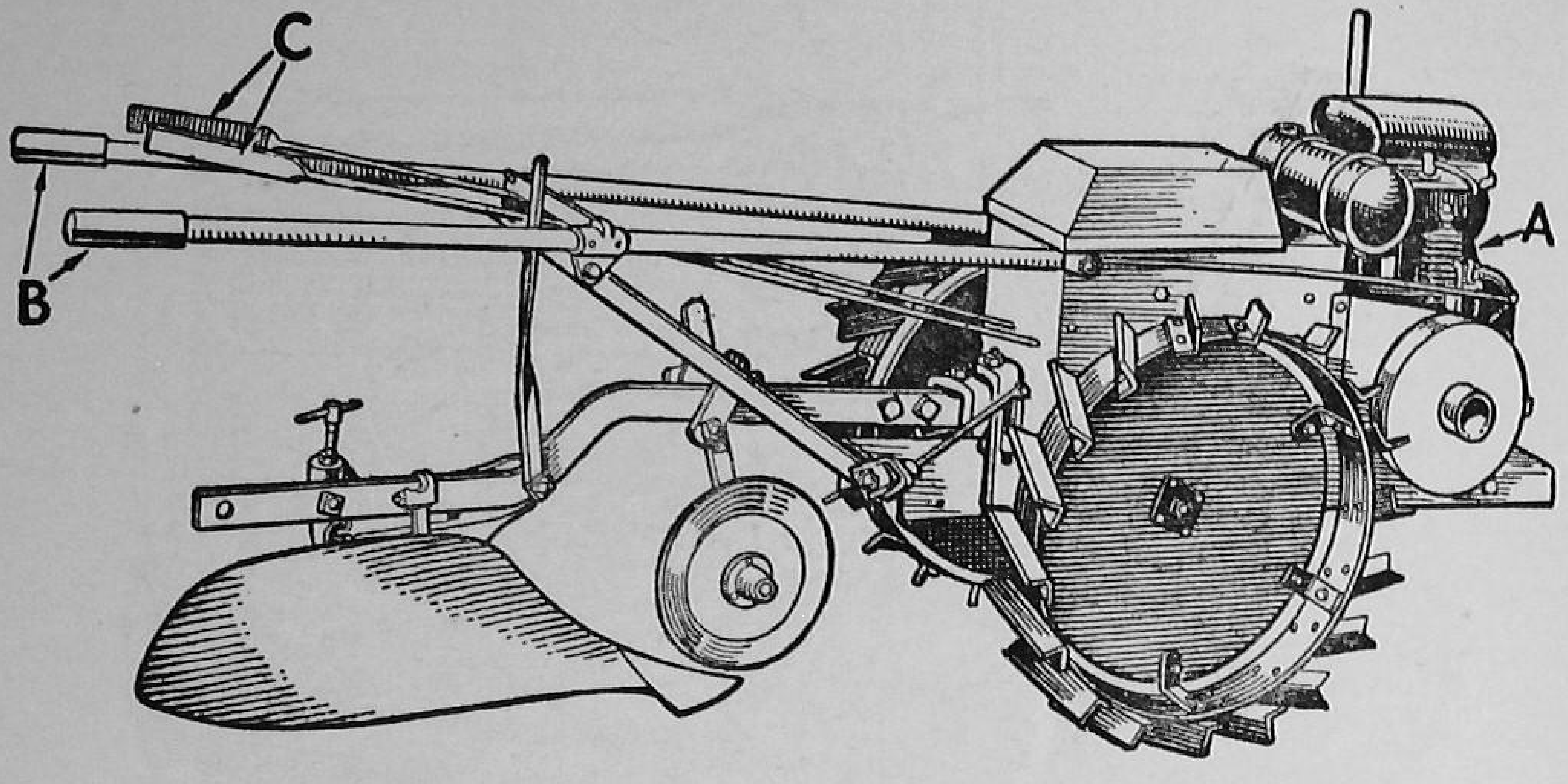
On some makes of tractor, a hydraulic pump is driven by the engine to provide power for lifting directly-mounted implements. In some cases the oil in the gearbox of the tractor is used as the hydraulic fluid. In others a special oil in a separate container is used. In America, trailer implements, as well as directly-mounted ones, are being designed for hydraulic control, and the fluid is conveyed from the tractor to the implement through a flexible pipe. Aircraft experience of hydraulic lifts for landing gear and other components has taught engineers much about mechanisms for remote control.

TRACTORS AND TRANSPORT

Here is a brace of topics about which everybody knows something; our author makes it all clear dealing briefly but skilfully with the history of farm power from the days when the ox and the horse were first domesticated to the present day when great ingenuity is displayed by some of the means of applying power to the land. Tractors of all sorts are discussed.

Oxen and Horses.

ALTHOUGH the domestication of oxen and horses made possible the development of farm implements as we know them to-day, it is likely that the horse, as the provider of farm power, will become obsolete in a very few years and will have been replaced entirely by the tractor or by some other mechanical means of converting fuel into energy for field cultivation. This is only because horses need too much labour to look after them



A TWO-WHEELED WALKING TRACTOR

The engine, A, is an air-cooled one of about six horse-power, and, in this particular model, the engine drives through a centrifugal clutch. When the engine is running slowly the tractor does not move forward at all. When the engine speed is increased by opening the carburettor throttle through a twist-grip control on the right-hand member of the steering handles, B, the clutch engages automatically, and the tractor moves forward. The drive to either of the two wheels can be interrupted by disengaging one or other of two dog clutches, through controls, marked C, alongside the steering handles. The use of these independently-controlled dog clutches helps very much in turning the machine sharply on the headland, because the tractor tends to gyrate, with its driven wheel describing the circumference of a circle and with the declutched wheel acting as a pivot. The directly-attached plough can be adjusted for depth of work and pitch of mouldboard. The plough can be detached, and other tools, such as cultivators and hoes, can be put on to the tractor instead.

and need too much land to grow their food. There is nothing absolutely restrictive in the use of horses for farm power, for although it is true to say that there is no field operation done by horses which cannot now be done equally well by tractor, it is also true to say that there is no operation done by tractor that could not be done by a sufficiently large team of horses.

Tractors.

Tractors at present in use are all powered by oil engines of one sort or another; some are petrol engines, some paraffin engines, and some heavy oil engines. Most tractors have either four wheels, or three wheels arranged like those on a tricycle. There are, however, some small two-wheeled tractors which are operated by a man who walks behind and steers the machine through handles in the manner of working a horse-drawn plough.

The Power.

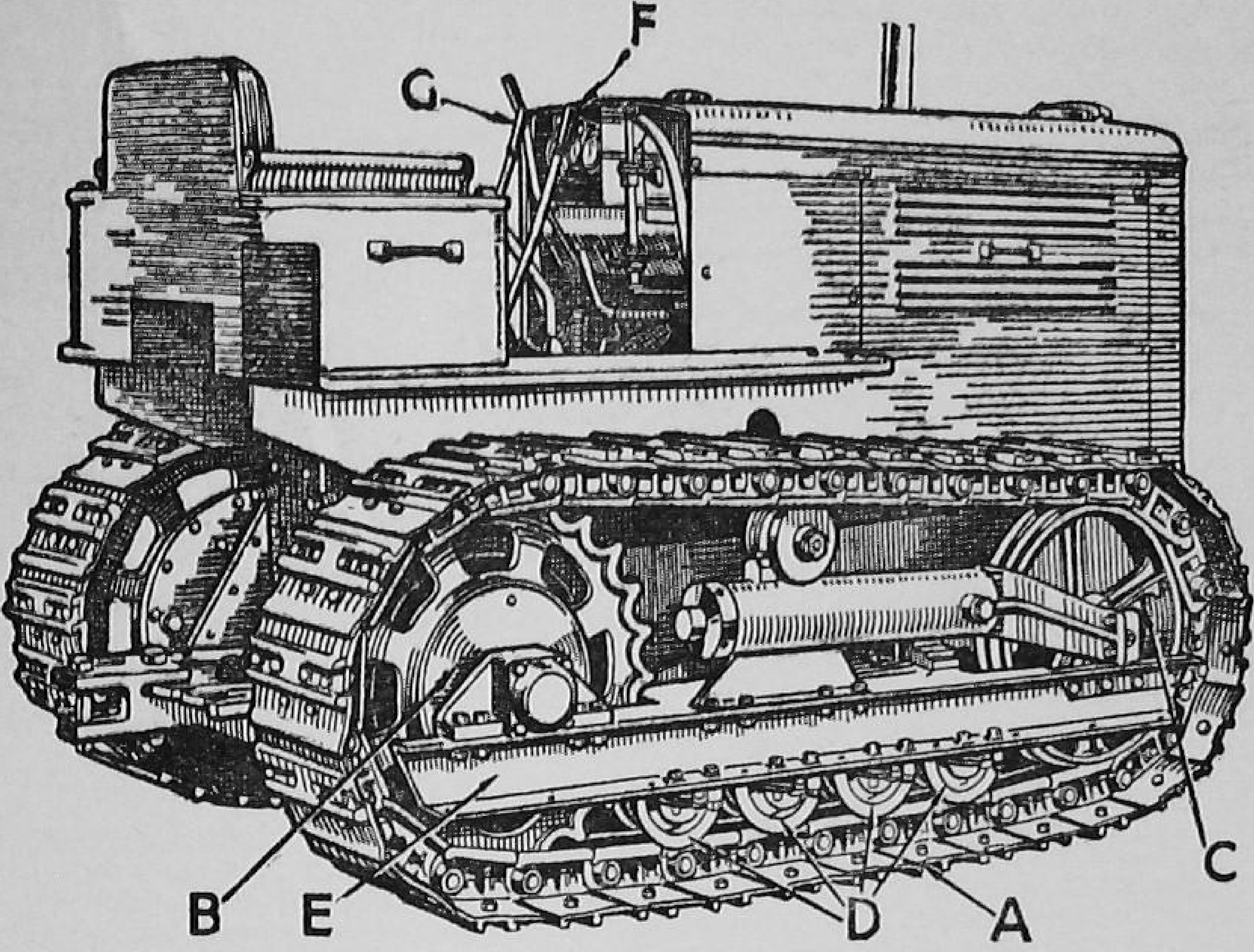
The power is transmitted to the rear wheels of four- and three-wheeled tractors through a gear-box and a differential. The main components, engine gearbox, back axle and steering gear, are very much the same as those on a motor-car or lorry; but a tractor has no road springs, its components are bolted rigidly to the back axle, and through unsprung articulation to the front axle. Also the forward speeds are much lower than those desired in a road vehicle, and so the reduction in gear ratio between engine and driving wheels is great. The engine must be able to develop its full power when the tractor is moving as slowly as two miles an hour.

Wheels and Tractlayers.

The driving wheels can be either spade-lugged steel wheels, or deep patterned rubber-tyred wheels. In some soil conditions, wheels of any sort find it difficult to get enough grip to transmit the power of the engine; therefore, tracklaying machines have been developed for agriculture as they have been for earth moving and other operations in civil engineering. Some track-layers are steered by slowing down the speed of the track on one side relative to the speed of the track on the other side; other models have ordinary pneumatic-tyred steering-wheels in front.

Transport.

Many farmers who have taken to using tractors



A TRACK-LAYING TRACTOR

The pin-jointed track or chain, A, runs over a driving sprocket, B, and an idler wheel, C. The rollers, D, rotating on spindles attached to frame member, E, help to keep the lower run of the track in contact with the ground. The handle, F, for the driver's right hand, releases the clutch transmitting the drive from the engine to the track on the right-hand side. The other handle, G, controls the clutch for the track on its own side of the tractor. Therefore the tractor can be steered by manipulating these handles F and G. The water-cooled engine of this tractor is of the compression-ignition type, burning heavy fuel oil. It has no sparking-plugs and magneto or other electrical ignition device, and no carburettor or vaporizer. Air alone is compressed in each cylinder and then a measured spray of fuel oil is injected into the cylinder when the piston is nearing the top of its stroke. The compressing of the air has heated it sufficiently to cause the injected oil to ignite. The explosion drives the piston downwards on its power stroke.

In general, tracks in place of wheels are more necessary in the case of large powerful tractors like the one in this picture than they are in the case of smaller tractors. Spade-lugged steel wheels, or pneumatic tyres well ballasted to help their grip, can transmit satisfactorily the power of a small tractor in most conditions of soil. The change-speed gearbox of large track-laying tractors usually provides as many as six different gear ratios for forward travel and two for reverse travel. Wheeled tractors usually have only three forward speeds and one reverse speed. Most tractor engines, and stationary engines used in agriculture, have a governor speed control. The speed-adjusting lever does not directly change the throttle opening the carburettor; it alters the setting of a governor which maintains the required speed of the engine, whatever the load may be, so long as it is within the capacity of the engine. On most engines the governor works by controlling the amount of fuel admitted to the cylinders; in some others it causes the engine to miss a beat when it is tending to run too fast. Each tractor engine has a definite, recommended, maximum speed for its governor to be set to give; and the manufacturers' ratings for speeds of travel in the various gear positions are calculated on this recommended engine speed.

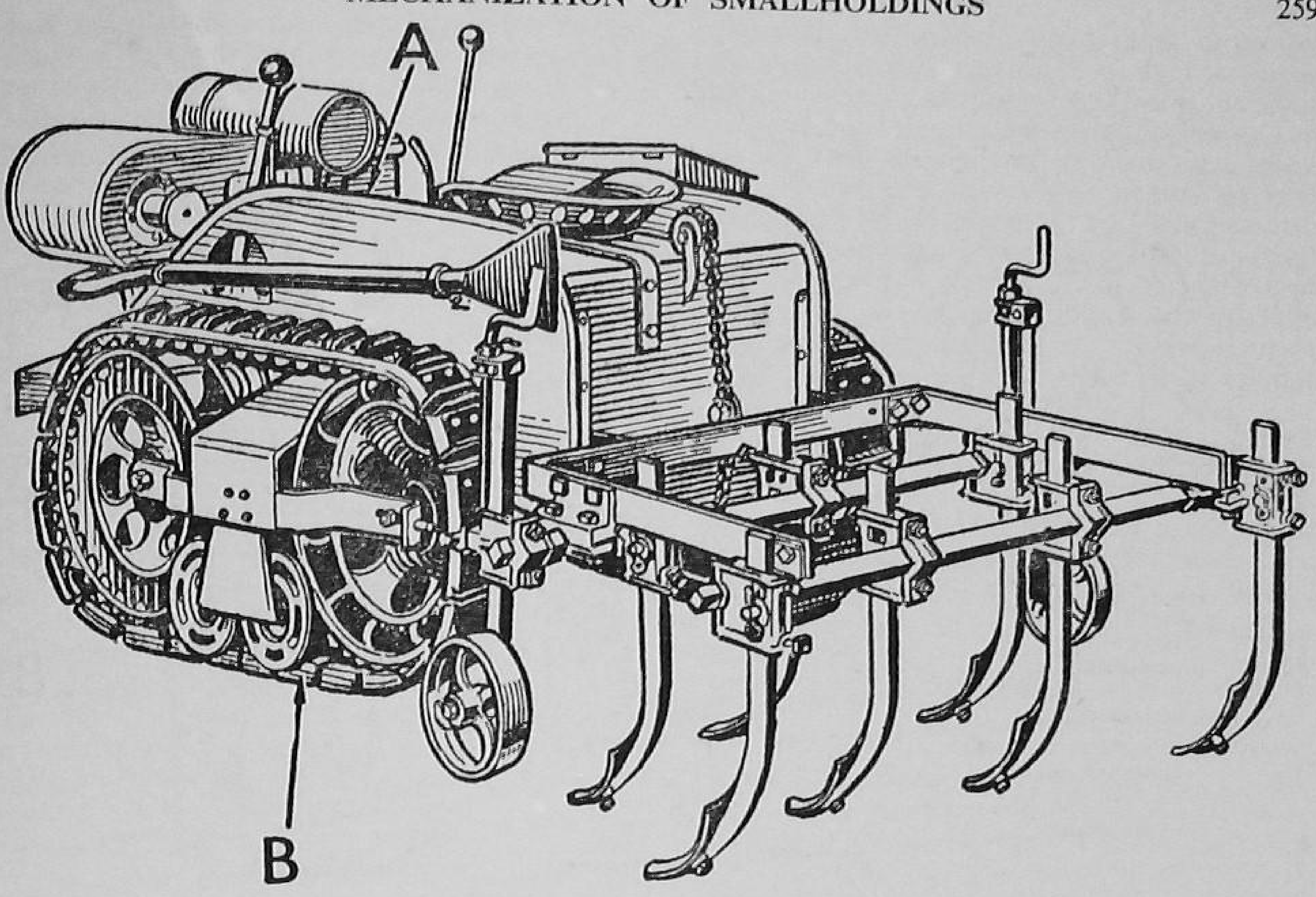
for all their field cultivations still use horse-drawn carts for transport about the fields, and at present this does seem cheaper and more convenient than keeping small tractors, or small cross-country vehicles of the Jeep kind, specially for field work. But efficient harvesting really needs vehicles of a kind that are equally satisfactory on roads and on fields, so that they can be run straight from the fields on to the road to take corn to the farmstead to be threshed or to take such crops as sugar beet and potatoes to the railway station. Such vehicles save the double handling of the load necessary when horse-drawn farm carts are used for bringing the produce from the field to the road. At the road the load has to be taken off and put into a motor lorry for journeys which would be too long to be made economically by horse-drawn vehicles. This requirement has not yet been met quite satisfactorily. A small light tractor has sufficient

power to haul a very heavy pneumatic-tyred wagon at high speed along a road, but it has not sufficient wheel grip to give the adequate braking and general controllability needed for safe road travel even when the wagon itself has a suitable braking system. However, improvements are sure to come, and the popularity of this kind of transport has already been enormously increased by the use of the pneumatic tyre which, in its application to tractors, wagons and implements, is probably the greatest contribution of this century to agriculture.

Tyres.

The iron-tyred wheel, however broad it may be, offers great resistance to movement over soft soil. The wheel sinks into the soil as it goes along, and is for ever having to climb out of the hole it has made for itself. Pneumatic tyres distribute the load over such a much wider area of contact with the ground that they sink in much less. Moreover, the shock-absorbing properties of wide section pneumatic tyres make it possible to dispense with springs, even when the trailer or cart is to be used at high speeds along roads. This enables the axle to be fixed rigidly to the body of the trailer, and the drawbar pull to be taken directly from the axle tree. This arrangement is much better for field work, because when the pull is from the body of the trailer, and the wheels do get stuck in extreme mud, the tendency is to drag the body off the axle, and something is likely to break.

The present limitations of tractor and trailer for road transport cause most farmers to keep also a motor vehicle, and a lorry or a van is really an essential part of the mechanical equipment of the farm.



A MARKET-GARDEN TRACTOR

This very compact tractor has a six horse-power air-cooled engine, A, and rubber-jointed steel-link tracks, B. It is small enough to work among fruit bushes and even in a glass-house. In this picture a directly-attached cultivator is fitted to the tractor.

Although tracks are not often necessary to transmit the power of such a small tractor as this, they are useful in the kind of work for which this particular tractor is designed. The ground pressure of the tractor is extremely small, since the track distributes the weight over a large area of contact with the soil, and so the tractor can be driven over finely-prepared garden soil without compacting it.

MECHANIZATION OF SMALLHOLDINGS

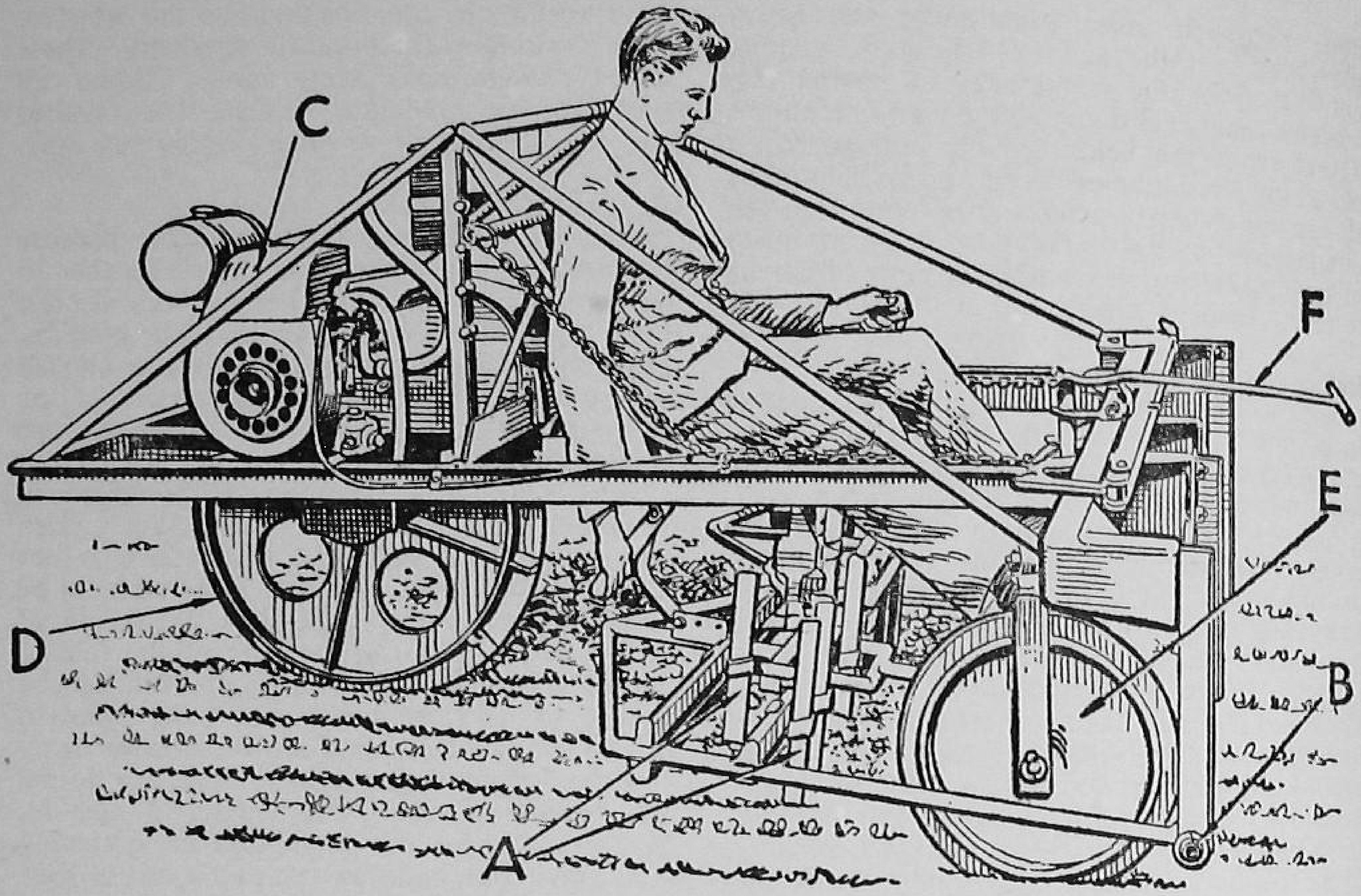
When we think of farm mechanization we are apt to think of broad fields suitable for implements and machines of high capacity. It is true that for efficiency in some parts of farm work, large scale work is essential, and there are people who believe that our farms, their size, setting out of fields, and mode of tenure, should be designed for mechanization, instead of machines being designed for work on farms as they already exist. But since mechanization means just using inventions to make work easier, it can be a blessing to the man who does all the work of a small holding himself, just as much as it can be an essential economic factor to the director of some enormous holding run by a financial corporation or a state. Moreover, we may come in the end to find that a conglomeration of tiny mixed farms is more efficient than a small number of large specialized farms.

Wheelbarrow.

We have seen that even the simplest tools of the farm are really machines, and so the smallholder is by no means neglecting the help given by mechanisms. If he were, he would be carrying all his poultry food, and hay, and produce, in his hand. Instead he uses a wheelbarrow. The wheel is the invention that gives the added carrying power. And now he has found that a pneumatic-tyred wheel on his wheelbarrow is better than an iron-tyred wheel. A narrow, iron-tyred barrow-wheel sinks into soft soil even worse than a cart wheel does, and the rim of the wheel is always a little below the surface of the ground. Therefore, the man who pushes the barrow has to make the wheel try to climb out of the rut it has made in the soil. It never actually climbs out of the hole, because it sinks into a new one and so makes a trench that marks its path; but all the same the man is virtually pushing the barrow uphill all the time he is pushing it over soft ground. A broad, elastic, pneumatic tyre makes a greater area of contact with the soft soil. The pneumatic-tyred wheel also makes the barrow easier to push along uneven paving stones.

Self-Propelled Tools.

Even very small market gardeners and the



A SELF-PROPELLED TOOLBAR

This slow-moving wheeled frame carries the hoe stalks, A, on a sub-frame pivoted at B. The outfit is propelled by a small air-cooled engine, C, which drives through the single rear wheel, D. The steering wheels, E, can be directed either by the handles, F, or by foot pedals. In the picture the pedals are being used and the handle has been folded forward out of the way.

It will be seen that the operator, sitting comfortably in a canvas seat like a deck chair, is quite near the ground and has a close view of the plants he is hoeing. This enables him to do the work accurately and with little fatigue.

When air-cooled engines are used on slow-moving agricultural machines they do not get the benefit of a cooling stream of air as they do when they are used on motor cycles and other road vehicles. Therefore, a fan has to be fitted. The blades of the fan are usually attached to the flywheel of the engine, and a cowl is arranged over the fan and engine to direct the air on to the cylinder. This cowl can be seen in the picture at C. The holes in the cowling around the pulley are for the inlet of the air.

Behind the driver's seat can be seen an air-cleaner and a tube leading to the air-intake of the carburettor. It is important that the air for the engine should be filtered free from grit, which would cause it to wear quickly. Since field machines are often working in a cloud of dust raised by the stirring of the soil, the air inlet for the carburettor should be as high above the ground as possible, and, even so, the air must be filtered.

holders of very small mixed farms use hand-pushed machines for sowing seed and for hoeing out weeds from between rows of growing plants. Some use horses for doing this work and also for ploughing. But now that small petrol engines can be made so cheaply it does indeed seem that the time has come when no holding, or even garden, can be considered too small to warrant the use of self-propelled tools. An engine of three horse-power is quite sufficient for working hoes and seeders and small cultivating tines, and a three horse-power machine is light enough and small enough to be handled comfortably in very small parcels of land. But the difficulty is finding a substitute for hand digging or horse ploughing. To turn a good furrow at eight inches deep in most kinds of soil needs a six horse-power engine. A six horse-power machine needs to be heavy. If it is light, the driving wheels will not be able to transmit the full power of the engine. Also, the larger engine needs a more substantial frame, and so the outfit really becomes too cumbersome to manage on a very small plot. Moreoever, the big machine is quite unnecessarily powerful for the jobs of seeding and hoeing, since the draught of the tools for each row is low, and since a wide bout of work cannot very well be done accurately by a tractor having a narrow tread width. This using of the machine at a capacity lower than its full power is a pity, particularly, because the hoeing and similar light operations have to be

done so much more often than the heavy ploughing, but the lack of efficiency is quite outweighed by the advantages of having one machine capable of doing all the field operations. Therefore, if the fields are big enough for a ploughing sized tractor to be manipulated, the all-purpose walking tractor is an acceptable means of emancipating the market gardener from much of his hard labour, or from the tyranny of having to tend a team of horses.

Ridges and Open Furrows.

A difficulty in changing over from hand digging to ploughing in small plots of land is that the ploughed land, if the work has been carried out with the conventional field plough, is not level; it has ridges and open furrows across it. The ordinary plough turns furrows only one way, usually to the ploughman's right. It is taken round and round the field, up one side and down the other. So half the number of furrow slices in the field slope one way, and half the other way. Therefore the field has alternate ridges and open furrows, the ridges being two furrow slices leaning against one another, and the open furrow being a trench between two furrow slices leaning away from each other. The ridges are the first things to be formed when the ploughing starts, and so they are called openings. The open trenches are the last things, so they are called finishes.

The contour of these openings and finishes persists even when the land has had its subsequent cultivating. In a large field this does not matter very much, in fact, in heavy clay lands the open furrows help to drain the land. If the openings and finishes are made in the same parts of the field year after year, the curvature becomes more and more pronounced. Some fields show clearly undulations which started as plough patterns probably many hundreds of years ago. The modern practice in ploughing is usually to set out the openings where the finishes were made last year. This keeps the field quite level for most kinds of large-scale farming, but for a small plot of land, particularly a market garden plot, there is much to be said for having the contour free from ridges and open furrows. With ploughing, this level contour can be managed only by arranging for all the furrow slices to slope one way. To accomplish this with an ordinary plough, the plough must be worked in one direction only. Its return journey back across the field must be an empty journey, with the plough lifted out of work. This wastes time, but ploughing is such a great saving of time and labour compared with hand digging that the inefficiency caused by this empty running can well be afforded. Nevertheless ploughs have been designed which will throw the furrow slice either to the right or to the left at the will of the ploughman, and these ploughs are becoming increasingly popular. The plough has two sets of mouldboard, share and coulter. One set is for working in one direction and the other set is for working in the opposite direction. These duplex ploughs have many names. Some call them one-way ploughs because the finished field has all its furrow slices sloping one way.

Right-and-Left Ploughs.

Others call them two-way ploughs because they are capable of throwing the slice either to the right or to the left. Perhaps the clearest thing to call them is right-and-left ploughs, though even that name could possibly be applied also to the ordinary plough which leaves the field cut into furrow slices some of which slope to the right and some to the left.

Most right-and-left ploughs are horse-drawn, but models are now made for market garden tractors, so here again the small farm is not bound to use horses. All the same, it cannot be denied that on a small general farm a couple of horses are very useful members of the family, for the grooming and bedding of them can be worked in with the tending of other animals. One or both of the horses can be used for many jobs besides cultivation work. They can do the field hauling of crops, the hauling of manure, the carting of feeding stuffs, and the gathering of hay and corn, and they can pull a cart or light trap to market.

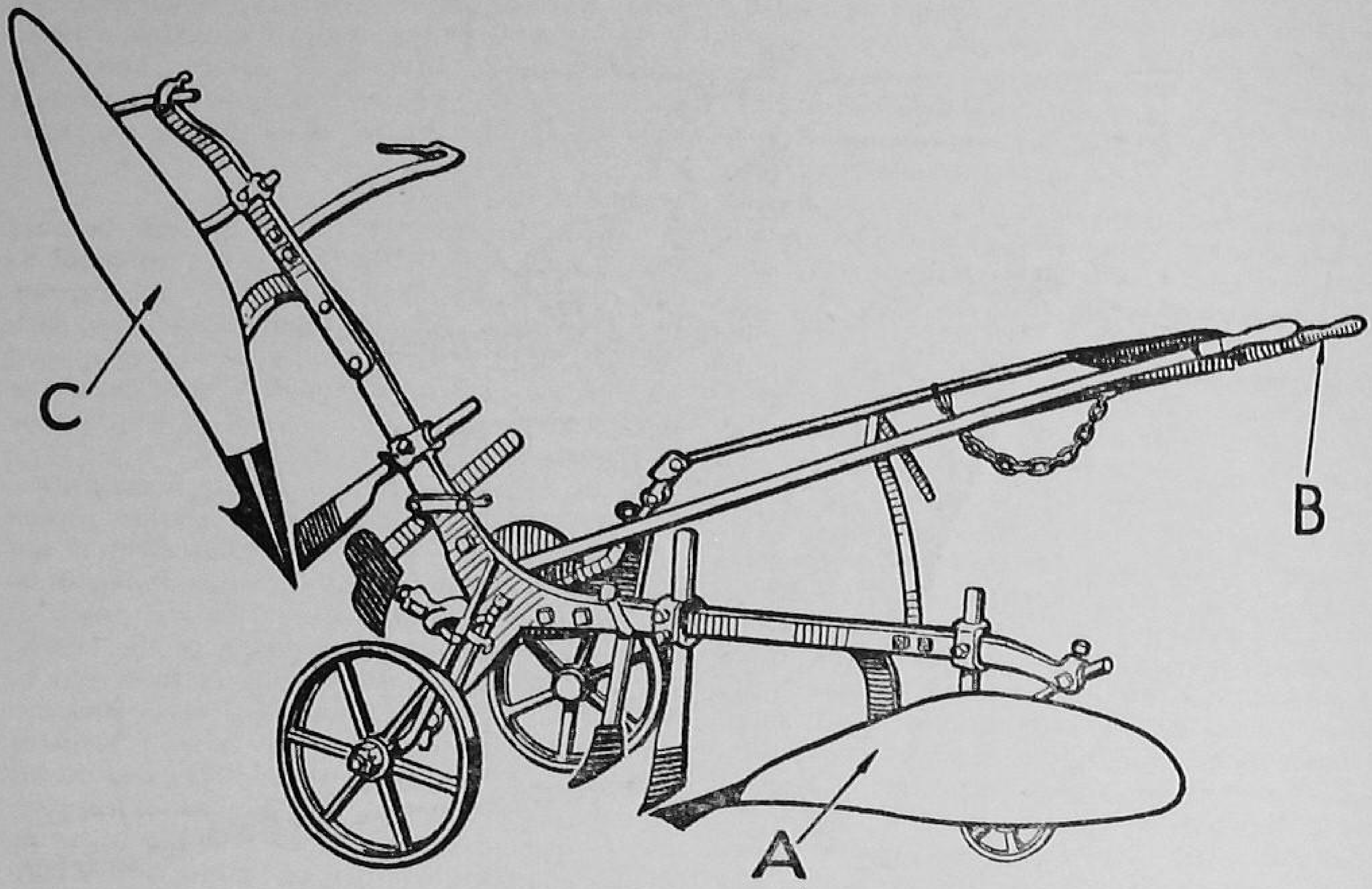
Petrol Vehicles.

On a large farm it certainly is worth while to keep a few horses to do light jobs which would not efficiently employ a tractor. The number of people working on the farm is great enough for the task of looking after the horses to be spread so that no one unfortunate worker is tied every Saturday and Sunday and holiday to being within range of the stables. It is the market gardener with no livestock who benefits most from being able to do without horses, and it is true that all of his jobs can now be done by petrol engine. Even the carting can be done by petrol vehicles that cost very little to buy. On holdings where the fields are not too hilly, old motor cars, with chains wrapped round their back wheels, can do field carting in most weathers. A powerful car will pull a trailer, but it is well to carry at least part of the load on the car itself, to help the grip of the driving wheels. The body of the old car can be taken off, and a flat dray or wagon can be built on in its place.

For going to market or for delivering produce, a motor-cycle with a box sidecar is faster, handier and cheaper, than a horse and float.

Contract.

Another alternative to keeping horses or ploughing-sized tractors on a small farm is to arrange for the ploughing to be done by contract. The disadvantage of this method is that the work cannot always be carried out just when the farmer needs it to be done, and a limitation is



A HORSE-DRAWN RIGHT-AND-LEFT PLOUGH

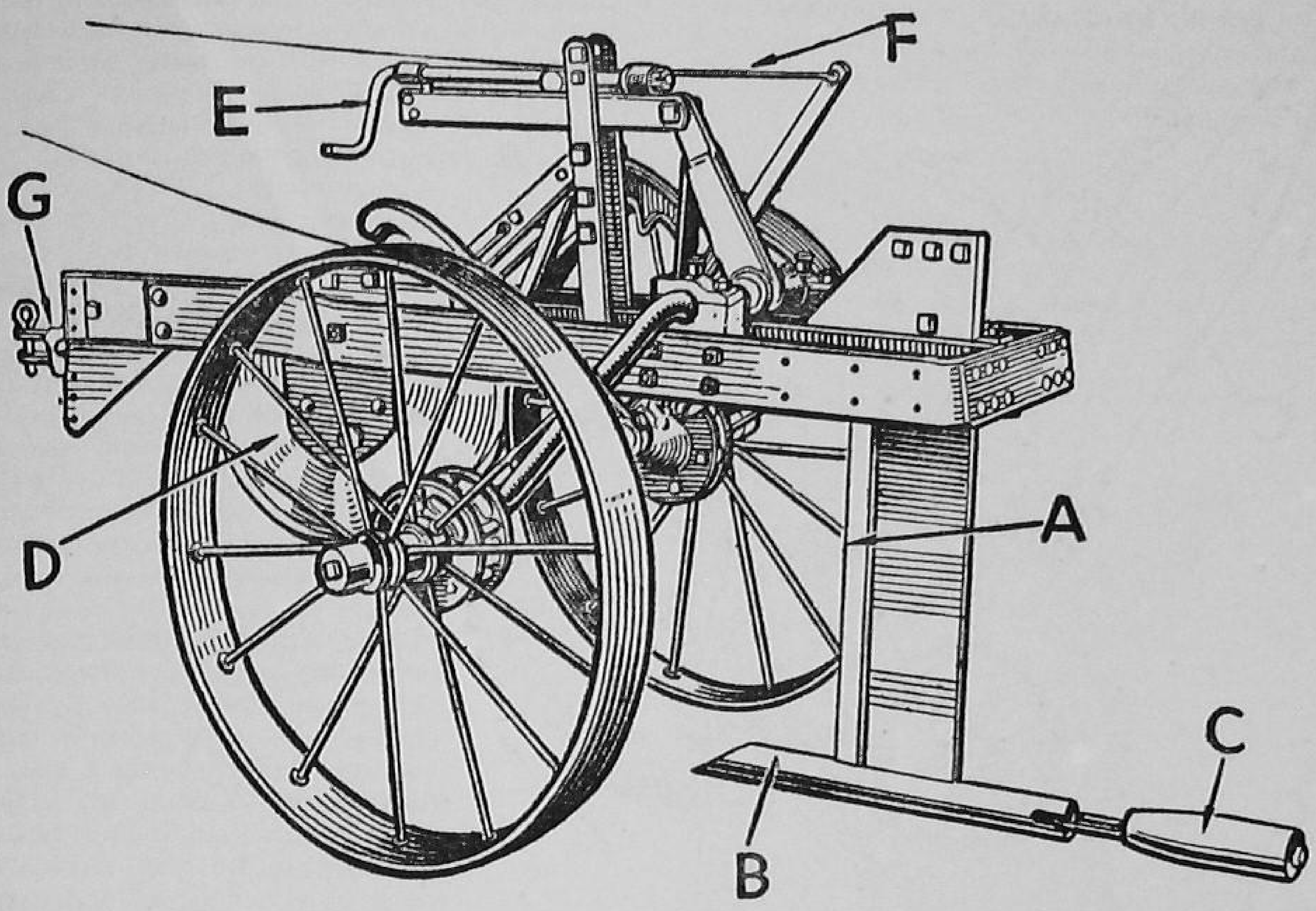
In this plough there are two complete sets of mouldboard, share and coulter. The set marked A is ready to work, and the ploughman walks behind the implement, holding the handles, B. At the end of the bout the frame is tipped over, pivoting on the wheel axles, so that the mouldboard and share marked C come into work. This is only one of several types of right-and-left ploughs. It is called the balance, or tipping, plough. Another kind, called the turn-over plough, has the two sets of mouldboard, share and coulter fixed opposite each other on one beam. To reverse the action of this plough it is turned over sideways on the beam as axis. In a third type, there is only one mouldboard, but the mouldboard has two faces, arranged rather like the two mouldboards of a ridging plough. To reverse the action all that is necessary is to tilt the body of the plough through approximately a right-angle. This is called the turnwrest plough.

For most conditions of soil and work, the balance type is the best. One great advantage is that it can be used with a very narrow headland. It is, however, unsuitable for sideling work, that is to say, work on a hill-side, not up and down the hill but along the side of it. The position of the out-of-work part of the balance plough makes it top heavy and liable to fall over if the slope of the land is great.

that if the fields are small the cost per acre will be high; and if they are very small they simply cannot be done with the ordinary tractor tackle used by contractors. But there is no doubt that even those small farms which can manage ordinary ploughing would benefit from occasional treatment by powerful machines which it would be quite uneconomic for the farmer to buy and keep for his own use. One such treatment is specially deep ploughing or cultivating, or subsoiling with a knife coulter, to break the pan which, in most kinds of soil, forms just below the furrow bottom level when land has been ploughed year after year to the same depth. This pan becomes hard enough to restrict the movement of water in the soil and to hamper the downward spread of plant roots. Pan breaking needs powerful tackle. Another occasional service needed by the heavy land cultivator is drainage. Draining can be done by porous tile drains laid in the ground at a depth well below the ploughing and cultivating level or, more cheaply by mole drains.

Mole-Draining.

Mole drainways, so called because they are merely tubular passages cut in the soil like the runs made by moles, are formed by drawing a pointed solid cylindrical piece of steel through the soil. This cylinder, usually 2 inches in diameter, is mounted at the bottom of a vertical stem. The stem is sharpened to a cutting edge in front so that it shall more easily make its way through the soil. The cylinder is called the cartridge or just the mole. Behind the cartridge, and attached to it by a free-swinging link, there is usually a tapered



A MOLE-DRAINING PLOUGH

The stem, with its cutting edge at A, holds the whole cartridge, B. C is the expander for smoothing out the walls of the mole passage. The disc coulter, D, is for cutting through the turf when the plough is used in grassland. The depth of the cartridge is controlled by handle E, and the implement is tripped out of work by pulling the cord attached to the rod F. G is the drawbar hitch for attaching the implement to a tractor or to a winch-cable.

A heavy track-laying tractor can pull a mole plough at the required depth, which may be as much as two feet. A light tractor cannot pull the mole by direct traction, but it may be able to manage the job through a cable winch. The tractor is anchored securely to the ground, and the power of the engine is used to drive a winch which winds in a cable attached to the mole plough. Then, when the cable has been hauled right in and the plough has come right up to the tractor, the tractor is moved to a new position. The cable unwinds itself, and the tractor is then anchored again to be ready for a further haul. The process is slow, but since the pull does not depend on wheel grip, and since the diameter of the winch drum and the details of its gearing can be arranged to wind the cable only very slowly compared with the speed of rotation of the engine, very high pulls can be attained with quite small, light tractors.

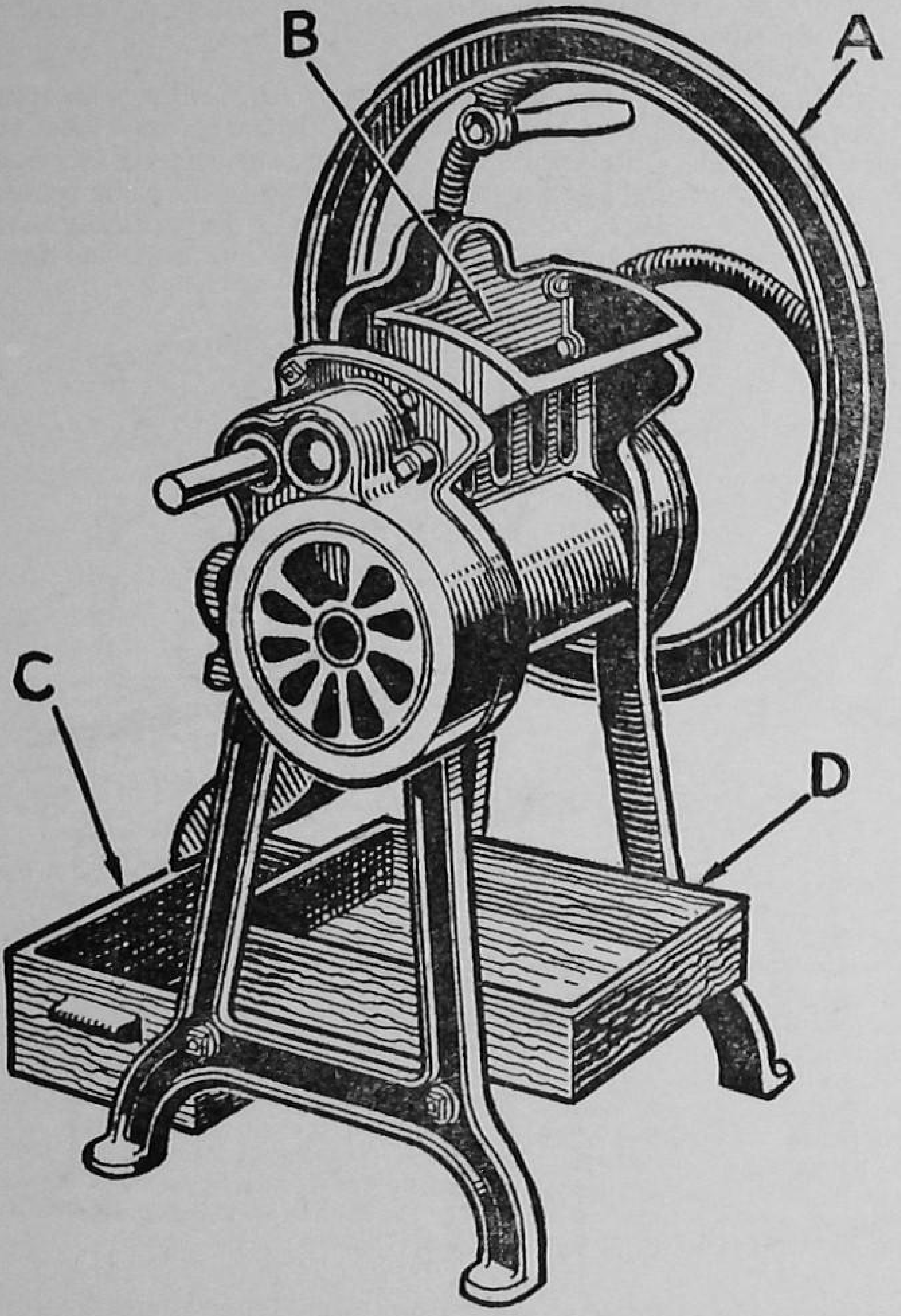
piece of metal, called the expander. This expander has, at its widest part, a diameter about half an inch greater than that of the cartridge, and it smooths out of the wall of the channel cut by the cartridge.

The stem is attached to a heavy two wheeled frame, something like the frame of a heavy plough, and the whole outfit is sometimes called a mole-plough. When the implement is being used to cut a drain in grassland, a disc coulter is fastened to the front of the frame to cut the turf and make easier the way for the mole stem.

In clay a mole drain will keep open for several years, even though it gradually squashes to an oval section instead of its original circular shape. In light crumbly soils the drain soon collapses or fills up with crumbs of soil, but fortunately soils of that nature do not often need to be drained at all.

FOOD PREPARING MACHINERY

The application of power to many forms of barn machinery is indicated and discussed and the layout of plant is explained. The different devices for dealing with the many different kinds of food are reviewed. Chaff cutting is considered. The potato sorter is described.



A CAKE BREAKER

The drive from the hand-turned wheel, A, is taken through reduction gears to provide a slow but nearly irresistible movement of spiked rollers. The cake is fed into the machine behind the plate B. The broken cake falls into box C; the very small pieces, powdered almost to a meal, fall through a grating into box D. Small machines such as the one illustrated here have only one pair of rollers. Larger, power-driven machines have two pairs. The second pair is set closer together and has finer spikes than the first pair. The cake broken by the first pair passes on to the second pair and is reduced to finer pieces. Each pair of rollers can be adjusted to bring the rollers closer together or farther apart. The nearer they are, the finer will be the broken cake. A machine of this sort, driven by a two horse-power engine, will break up two tons of cake in an hour.

Concentrated foods for cattle can, of course, be bought as ground meals or small biscuits, called nuts, which need no breaking; but flat cakes are more convenient to store and are usually cheaper.

Barn Machinery.

MANY cattle foods, both those grown on the farm and those bought in, need to be sliced or ground up before they are acceptable to the stock. Some of the produce sold off the farm for human food also needs to be cleaned and graded. The machines for doing these jobs are called Barn Machinery, to distinguish them from the Field Implements such as those we considered in our earlier sections. Many forms of barn machinery are power-driven, and farmers who have to use a group of barn machines usually fit up a line of shafting and belting and keep each machine permanently bolted down on to its own particular place on the floor of the barn. The engine is usually housed in a small building adjoining, and either the shafting or a belt passes through an opening in the wall. A six-horse-power oil engine or electric motor is large enough to drive a selection of the normal sized barn machines unless it is likely that more than one of them will have to be working at the same time.

Sturdy Machine.

Oil cakes, such as linseed and cotton and soya bean cakes, are very hard to break and a sturdy machine is needed to crush them. The cakes are dropped into a hopper and they are caught between two spiked rollers. When they have passed through these they go on to another pair of rollers which have spikes smaller and set closer together than have the first pair of rollers. This second pair of rollers breaks the pieces up still smaller. In each pair of rollers the distance between the two members can be adjusted to give different sized pieces of cake. In the process of breaking, some of the cake crumbles into a powder or meal, and most machines allow for the broken

cake to pass over a sieve so that the crumbled meal can fall through the grid and be collected separately.

Grinding Mills.

Grain is usually crushed or milled before it is fed to stock. It is not always wise to grind it very fine. Different cattle need different size of particle. Therefore grinding mills have adjustment for the degree of grinding, and also there are distinct machines to produce very coarse feed and very fine feed.

To form the coarse kind of feed, such as the kibbling of maize for poultry, a crusher with rollers like a mangle is used. These rollers are metal and if the machine is to be used only for crushing oats they are smooth faced, since all that the mill is required to do is to burst the seed coat of the oats. If the machine is to crack maize, the rollers are fluted. The spindle of one of the two rollers can be moved a little across its axis to adjust the distance between the rollers and therefore the degree of crushing. Also, this moveable spindle is spring loaded, so that if some hard foreign substance gets into the mill, the roller can give way enough to prevent the machine being damaged.

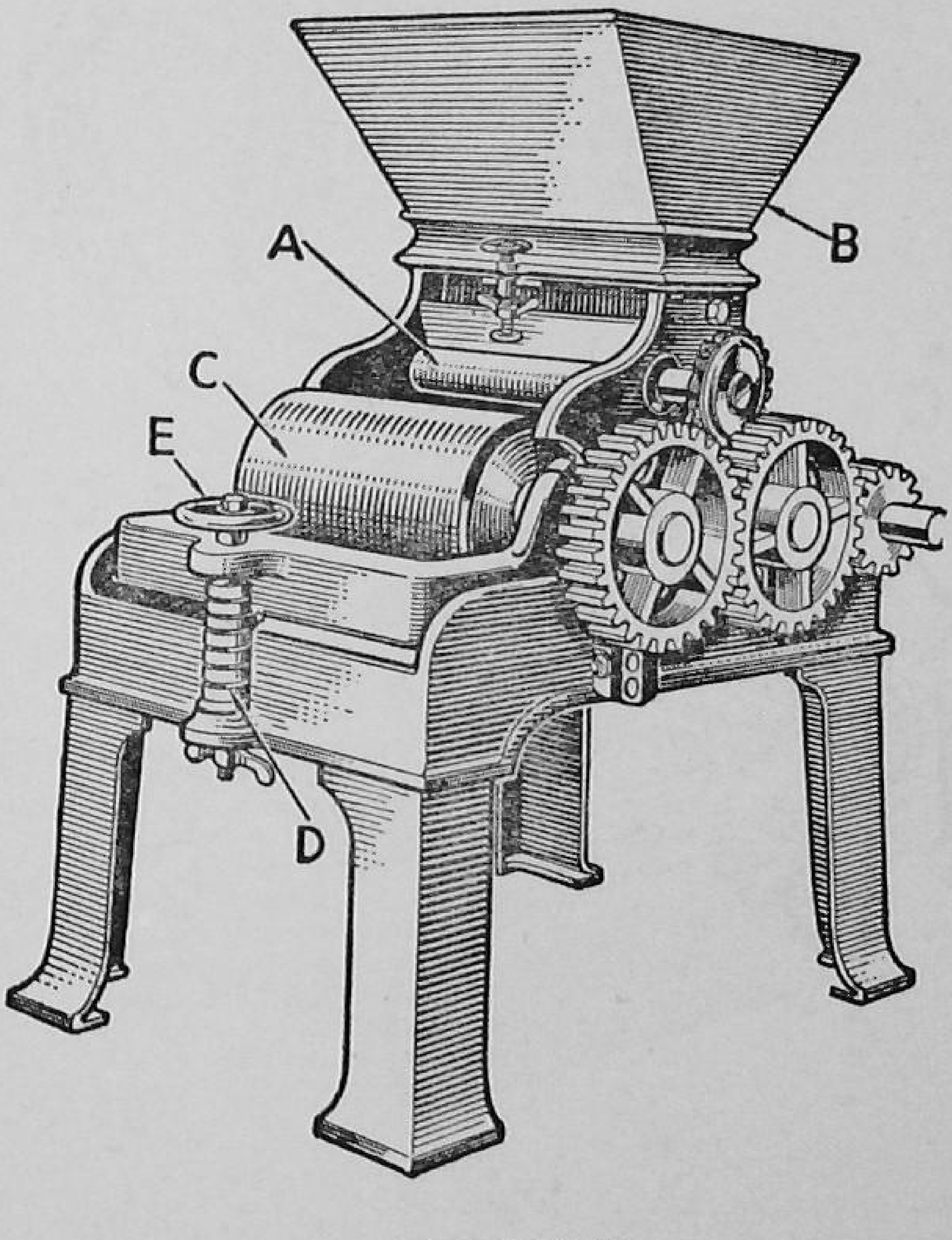
Finer Meal.

To produce finer meal a machine is used in which the grain is passed not between rollers, but between vertical ribbed discs. One of these discs remains stationary, the other is rotated. A worm-thread on the spindle feeds the grain between the discs near their centre. At the centre of the disc the grooving is shallower than it is at their periphery, and the rubbing surfaces are further apart. The meal becomes finer and finer as it works its way towards the edge of the discs. Since the corrugations on the discs would be damaged if they were in contact when the mill was running with no grain passing through it, a spring is threaded on the spindle. This spring keeps the discs well separated except when the grain is flowing and the adjusting handle has been screwed down to bring the plates close enough to each other to yield meal of the desired fineness.

In early machines of this type the discs were of buhrstone, and although the discs are now made of chilled iron the mills are still sometimes called Buhr Mills. Other names for the same machine are the Plate Mill and the Grist Mill.

Combined Mills.

Mills of small capacity for dealing with feed for a few head of stock are often made as Combined Mills. These are a crushing or kibbling mill, and a plate mill, built into the same frame. Except that the one roller of the crushing part of the mill is on the same spindle as are the discs



A CORN CRUSHER

This rolling mill has a feed roller at A which takes the corn from the hopper B, and passes it to the crushing rollers. One of the crushing rollers can be seen at C. The spiral spring at D allows the housing of the spindle of roller C to move a small distance. This lets the rollers separate enough to allow stones or nails or other foreign matter to pass without damaging the rollers. The hand-wheel, E, adjusts the pressure between the rollers. A mill of this kind cannot grind grain to a fine meal; it can only flatten out the grain and burst the husks so that the digestive juices of the animal eating the food may more easily reach the inside of the grain. Oats are crushed, or "rolled" for horses, and maize is cracked, or "kibbled" for poultry. For kibbling maize fluted rollers are needed.

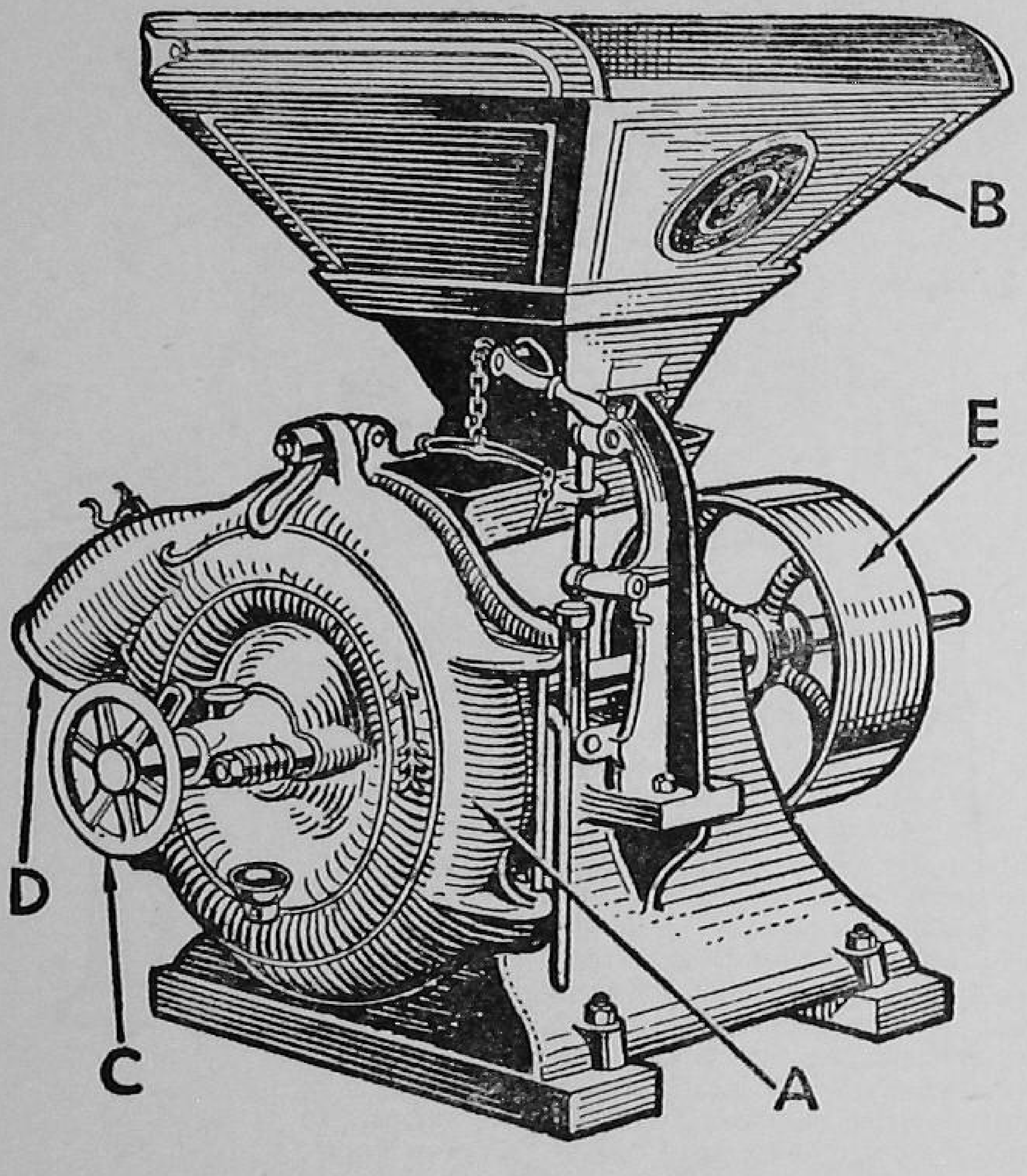
A three horse-power mill will crush twenty bushels of oats in an hour.

and the common driving pulley, the machines are quite distinct. The hopper is divided into two halves. One half feeds into the crushing mill and the other half into the plate mill.

Hammer Mills.

Large plate mills are now being replaced to some extent by Hammer Mills. These mills have a cylinder made up of rotating hammer heads. On some models these hammers are fixed rigidly to the rotor; in others they are hinged and free-swinging. The rotor moves at a very high speed; 2,000 revolutions per minute is quite usual, and the corn is struck so hard that it just disintegrates. Below the hammer rotor is a screen. The material stays above this screen, and therefore within the reach of these vicious hammers, until it is fine enough to fall through the openings in the screen. Interchangeable screens, of different mesh, are provided.

Hammer mills will accept nearly anything and grind it to a meal. Corn, hay, straw, all are "grist to this mill." It is common practice to feed whole, unthreshed oats or barley or wheat into the machine to give a compound meal of flour and roughage.



A GRINDING MILL

This large machine has metal plates within the housing A. The corn is fed into the hopper B. The hand-wheel, C, adjusts the distance of separation of the plates. The ground meal leaves the mill by the outlet D. E is the pulley for the driving belt. At the base of the hopper can be seen the chute along which the grain pours into the housing to be carried along the worm thread of the spindle until it is between the two grinding plates. The chute has a riddle, forming a false bottom, which keeps back large foreign bodies such as stones and nails which would damage the plates. To keep the riddle working, this chute is kept agitated by a cam which shakes the bracket from which one end of the chute is suspended.

A three horse-power mill of this kind can grind six bushels of grain to a fairly fine meal in an hour.

Advantages.

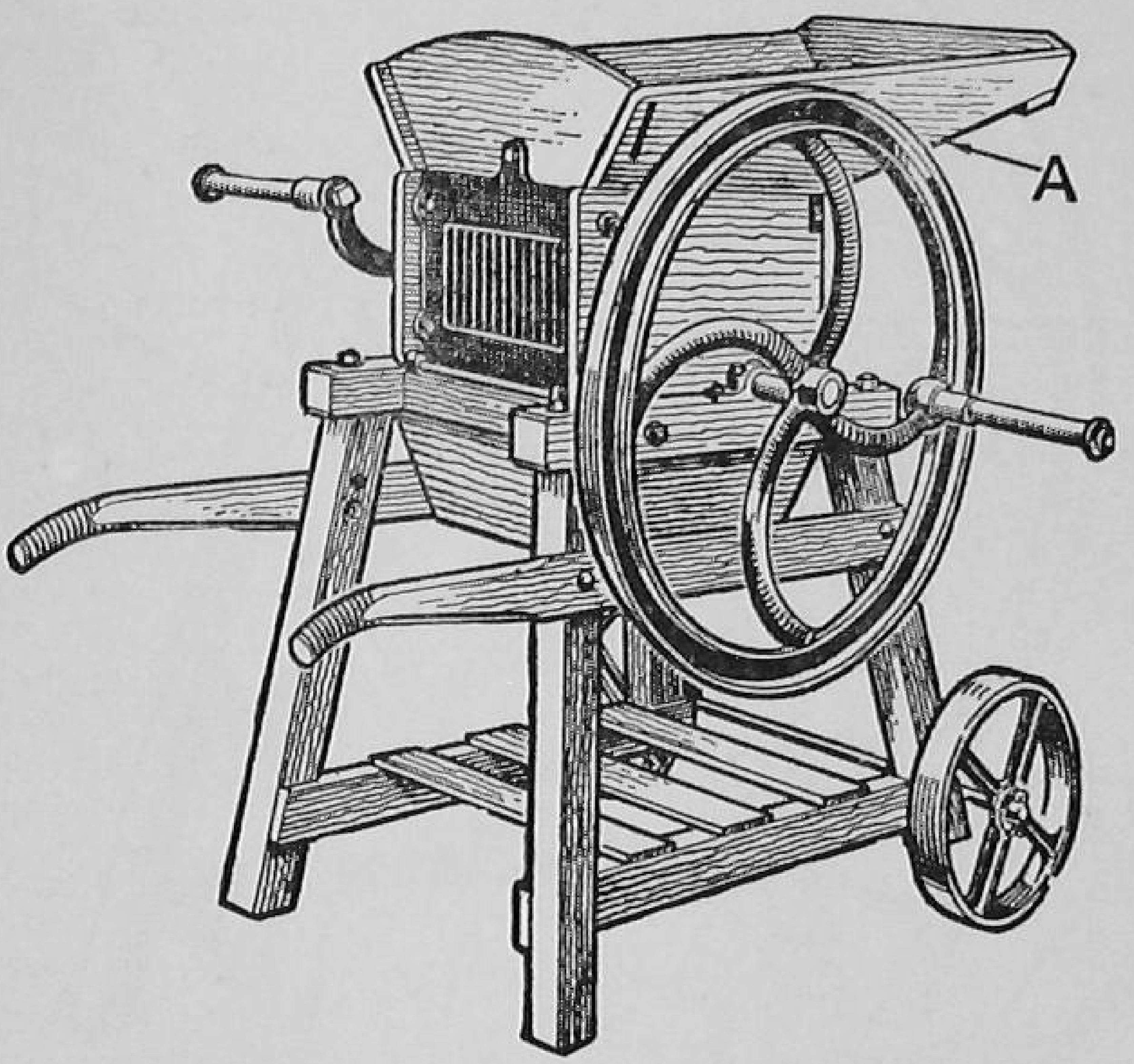
The advantages of the hammer mill are many. There is little to wear out; the only bearings are the main ones for the rotor shaft, and they are usually roller bearings which are long lasting and easily replaceable. The hammers have hardened contact faces. Usually two faces are hardened so that when one side of the hammer has worn it can be turned round and so caused to present a fresh face to the corn; and complete replacement is easy and not expensive. The hammer mill is not damaged by being allowed to run empty, and any foreign substance admitted with the corn needs to be very big and very hard to damage the machine. It is said that an old boot that found its way into the hopper of such a machine did no damage and came out as a finely ground meal.

Hammer mills are more often made of large capacity than in small sizes, and usually a pneumatic elevator to put the meal into a loft or a truck is incorporated. The air pressure for the elevator is generated by a fan mounted on the same shaft as the hammer-rotor.

Roots.

Roots, such as swedes and mangels, are cleaned and sliced before they are fed to sheep and cattle.

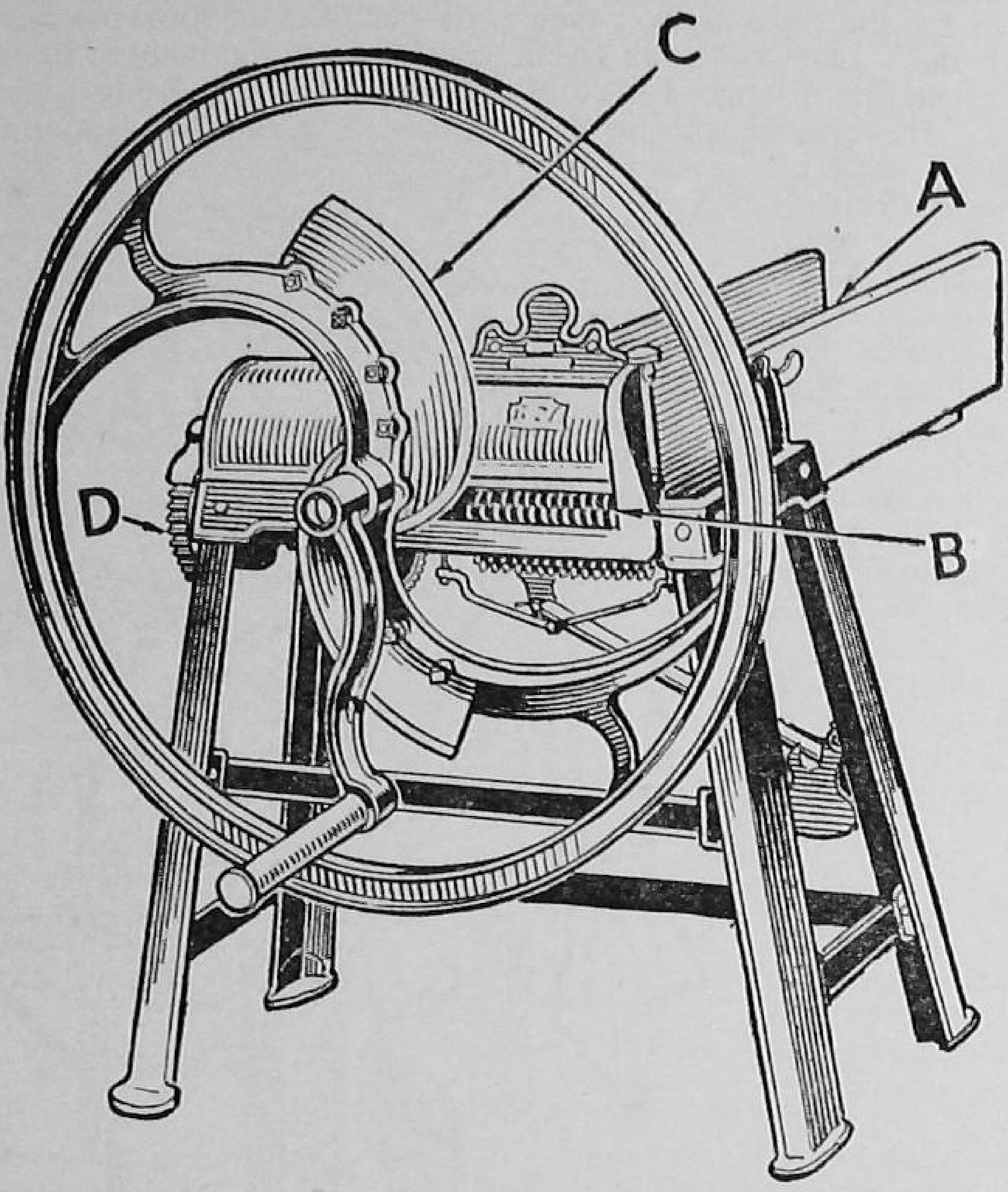
In the usual machine the whole roots fall from a hopper into a rotating cylindrical cage made up of bars. Some of the bars are straight, others are twisted into a spiral; both kinds of bars



A ROOT-CUTTER

This machine, which is mounted on wheels so that it can more easily be moved about the yard or the sheep-folds, cuts mangolds and turnips into slices. In the machine shown in this picture the cutting is done by a rotating barrel which has sharp-edged projections on it. Root-cutting requires only very little power, and a hand-driven machine such as this one has quite large capacity. The floor of the chute of the hopper, marked A, is made up of bars in the form of a grid, so that any dirt that gets knocked off the roots can fall through to the ground and not be taken on into the machine.

Most of the larger, power-driven machines have discs, instead of barrels, to do the cutting. The disc has sharp-edged gouges on it, as the barrel has, or it is fitted with detachable concave knives. In both kinds of machine the size and shape of the root slices or fingers delivered can be changed by fitting a different barrel or disc into the machine. On some of these barrels and discs the apertures and gouging projections are so small that the roots are grated into pulp. In one kind of barrel machine, the edges of the projections in the barrel are arranged so that turning the handle in one direction produces slices, and turning it in the other direction produces fingers.



CHAFF-CUTTER

In this illustration of a hand-turned machine, A, is the chute into which the uncut straw or hay is pushed. B is the toothed roller which seizes the straw and feeds it towards the knife. C is one of the curved knives which cut the straw or hay. It is attached to the spoke of the heavy flywheel by four nuts and bolts, and it can easily be detached when it has to be sharpened or renewed. D is one of the gear-wheels in the train of gears that drives the feed roller. These gears can be changed to alter the speed of the roller relative to the speed of the flywheel and knives. Since this changes the relative speed at which the straw or hay is fed towards the knives, it controls the length of the pieces of cut material which make up the chaff.

On some makes of machine a change of gear ratio can be obtained by turning round, end to end, the spindle on which the worm gear for the right-angle drive is cast. The spindle has a coarse worm thread at one end and a fine one at the other end. This method does away with the need for spare loose parts which might get separated from the machine and lost. It can provide for only two ratios, but these are usually adequate. Chaff an inch long will serve for cattle and horses; for sheep, it is cut very small, about a quarter of an inch long. Large power-driven chaff cutters have a change-speed gearbox instead of loose detachable gears. Often they have also a reverse gear which is useful for clearing the machine if it becomes choked.

A three horse-power machine can chaff a ton of hay or straw in an hour.

contribute to the scraping and shaking of the roots as they pass from one end of the cylinder to the other. The angle of the cylinder to the horizontal can be adjusted so as to change the length of time taken for the roots to find their way through the cylinder. Dirty roots are given a gentler angle, and therefore a longer period of time in the cylinder. This cleaner will not deal with roots that have wet mud on them, but it does very effectively get the soil away from dry roots. The dirt falls through the bars of the cage. From the lower end of the cylinder the roots fall into the hopper of a slicing machine. The roots are forced by a worm gear to travel towards a vertical rotating disc. This disc has holes in it; and each hole is partly encircled by curved knives. The sharpened lips of these knives face in the direction of rotation of the disc. The roots are cut by the knives, and the sliced-off pieces are pushed out through the openings in the disc to the delivery shute.

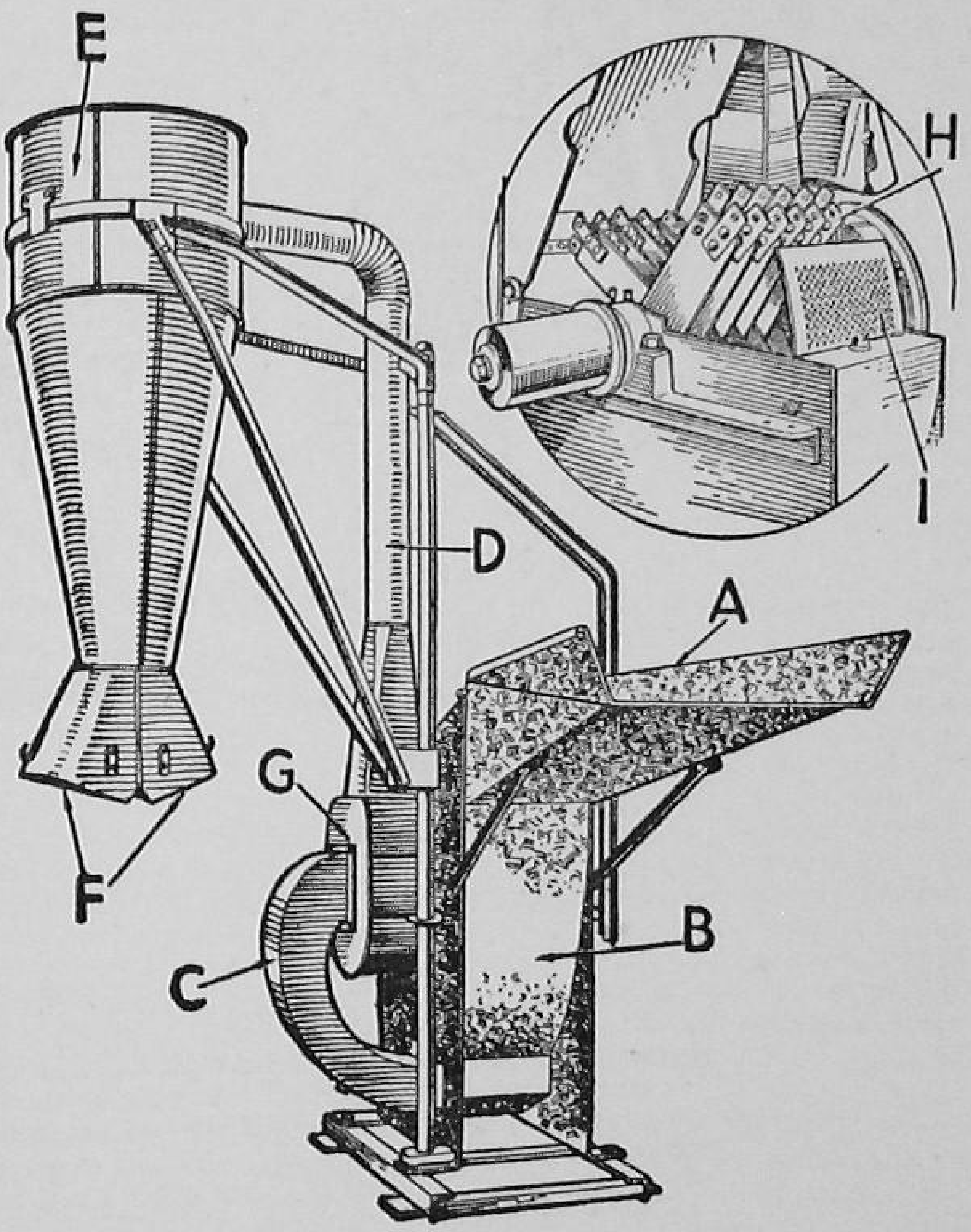
Hand-Driven Slicers.

Small hand-driven slicers, without the cleaning cage, are sometimes used in the field where sheep are being fed. The combined cleaning and slicing machine is usually engine driven, and if the implement is to be used in the field a small air-cooled motor is best. An air-cooled engine is lighter and smaller than one that is water-cooled, and it can be built actually into the framework of the machine, making the whole outfit portable. Moreover, if the outfit has to be left in the field over a frosty night, there is no water to freeze and crack the cylinder or hopper.

Another outfit, designed for getting sliced turnips on to grassland which is not fully supporting the sheep, is built into a horse-drawn cart. The mechanism is driven from the cart-wheels and the sliced turnips fall directly on to the field.

Chaff Cutter.

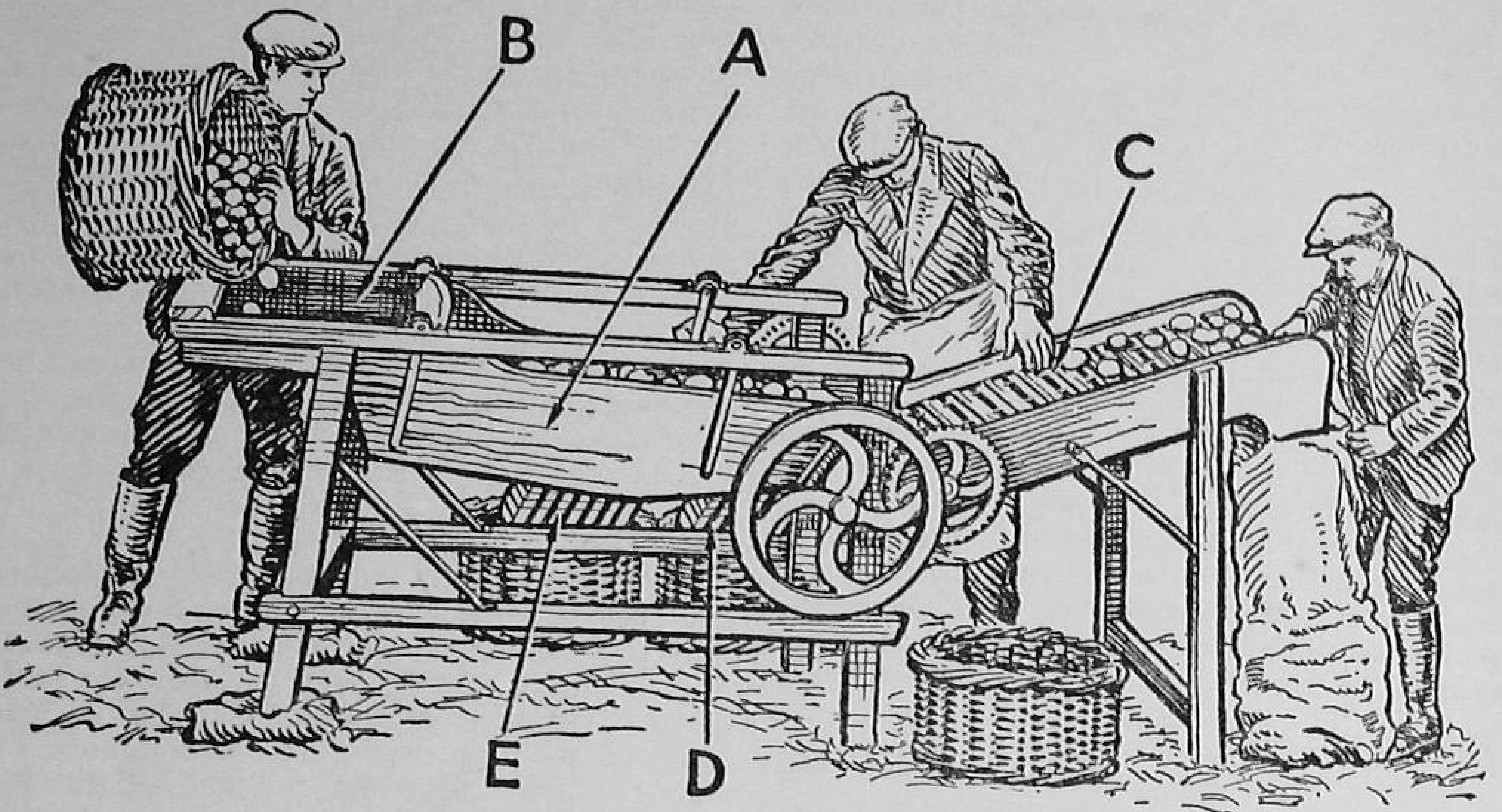
A barn machine of which the function has changed but not the mechanism is the chaff-cutter. The small type which is on nearly every farm and which at one time was regularly employed to cut up hay and oat straw to feed horses and cattle is now little used. Large power driven machines, however, are much used with threshing tackle. Some stockmen prefer cut straw to uncut straw for bedding; the short pieces are more absorptive, and also, if the manure has to be spread fresh, before it has rotted down, short straw manure is easier to spread than is long straw manure.



A HAMMER MILL

The corn is fed through the hopper, A, on to the revolving hammers which are inside the casing, B. When the meal is fine enough to fall through the screen or sieve beneath the hammers, it drops into a trough from which it is elevated pneumatically through pipes, C and D, into the delivery reservoir, E. Bags are filled at the outlets, F. The draught of air for elevating the meal is generated by a fan in the housing at G. This fan is on the same shaft as the hammers. The hammers, H, can be seen in the smaller picture where the cowl has been removed for the screen, I, to be taken out. It will be seen that each hammer-head has three holes in it, so that it can be replaced upside down to present a new hammer face when the original one has become worn by use.

The degree of fineness of the meal depends on the size of the mesh of the screen, and several different screens are provided with the machine. Hammer mills are usually made in large sizes, and many are driven by a stationary tractor instead of a fixed power unit. The tractor can be used for this job when the weather is not suitable for field work. Large quantities of grain can be ground in a short time. A sixteen horse-power machine can grind forty bushels of grain in an hour.



A POTATO SORTER

This particular type of sorter has a reciprocating frame A, which contains two riddles, one above the other Unsorted potatoes are tipped into the hopper, B, and they fall on to the upper riddle which retains potatoes large enough for ware and passes them on to the elevator C, which carries them towards the bag. While they pass up this elevator the operator, who is turning the handle of the sorter with his right hand, uses his left hand to pick out faulty potatoes and foreign matter. The smaller potatoes have fallen through on to the lower riddle. The medium-sized ones, for seed, are held on this riddle and slide down the chute, D, into a basket. The smallest ones, the chats, fall through the riddle on to another chute, E, and slide into another basket. Another common type of potato sorter has a rotating cylindrical sieve instead of the reciprocating riddles. The cylindrical sieve is on a sloping axis, and has smaller mesh at the upper end than at the lower end. Chats fall through the fine mesh, seeds fall through the large mesh, and the ware passes right through the cylinder to be bagged. Both kinds of sorter have their own advantages, but the reciprocating riddle type give better opportunity for a final hand picking of the ware to remove faulty potatoes. The size of mesh in the riddles or the cylinder has to be changed when the classification of sizes acceptable for marketing are altered. With both kinds of machine this change is easy. In the cylindrical machine the two halves of the cylinder, fine mesh and coarse mesh, are made separately and can be changed independently of each other.

The essential mechanism in nearly all chaff-cutters is a series of curved knife blades fixed to the spokes of a flywheel. When the flywheel rotates, the knives slide against a stationary shear-plate. The chaff is fed towards this rotating knife by two toothed rollers. In small machines the straw is pushed into these rollers by hand; in big ones, a feeding table, consisting of an elevator belt running in a horizontal trough, is used.

The length of the pieces of straw or hay composing the chaff can be varied by changing the speed of the straw or hay moving towards the knife, relative to the speed of rotation of the knife. This ratio can be adjusted by shifting the change-speed pinions in the drive to the feed rollers.

A modern use of the chaff-cutter is for cutting up green material to be made into silage. Special silage-cutting machines have a powerful fan, rotating in a casing which contains also the fly-wheel-knife. This fan blows the chopped-up material along a pipe to the silo or stack.

Potato Sorter.

Another machine which can be classed as a barn machine, although it is more often used in the field—at the potato clamp—is the potato sorter. This machine grades the crop into three sizes—ware, seeds and chats. Ware are those suitable to be sold for human food, seeds are for planting, and chats are used for feeding stock and for industrial processing. One of the usual types of sorter has a rotating cylindrical wire sieve. The axis of the cylinder slopes, and the potatoes to be sorted are fed into the higher end. The mesh of the wire sieve forming the upper part of the cylinder is of a size to allow chats to fall through into a tray set to receive them. The mesh of the lower part allows seeds to fall through. The large potatoes go right through the cylinder and fall on to an elevator belt. This belt runs nearly horizontally for a considerable distance, a long enough distance to allow operators, standing or sitting alongside the belt, to pick out faulty potatoes and foreign matter as the wares pass on their way to the bagging hopper.

DAIRY MACHINERY

The milking machine is praised and its work explained to us. The mechanical cream-separator is described.

The outstanding need that arable farming has for machinery is to help it over peak periods of high labour demand; dairy farming needs machinery to help it in the everyday, incessant work inseparable from a business which harvests its crop twice a day and sells it once a day, and sometimes has to deliver it once a day as well.

Milking Machine.

The greatest saver of time and men is the milking machine. Milking by hand needs experienced workers, and, however skilled the worker, he has to spend ten minutes or a quarter of an hour at each cow.

The Milking Action.

The milking machine more nearly reproduces the milking action of the calf than does hand-milking. The teats are subjected to both massage and suction. On to each teat is fixed a rubber-lined metal cup. The rubber liner does not fit tightly into the metal cup: between the liner and the cup is an annular space. At regular intervals, about fifty times a minute, this space is partly exhausted of air, to match the vacuum which is maintained on the teat side of the rubber liner. The equalizing of the vacuum on either side of the rubber causes the liner to return to its normal unstressed shape; but as soon as the atmosphere is readmitted to the annular space the rubber liner is pressed inwards. Thus a pulsating squeeze is imparted to the teat.

The milk is sucked away into a pail, or along a pipe-line and through a cooler straight into the churns.

Vacuum Pump.

The suction needed for operating the machine is provided by a small vacuum pump. Usually this pump is a simple piston pump, and it is driven by a petrol engine or an electric motor. To even out the pressure a reservoir is used. The teat-cups are connected to this reservoir, not straight to the vacuum pump. The air in the reservoir is kept at a pressure of about half an atmosphere, that is about 7½ pounds to the square inch.

The saving in time that is taken in the operation of milking comes from the fact that one man can look after several cows all being milked at the same time. Once a cow's udder and teats have been cleaned, and the fore-milk has been drawn off, and the teat cups of the machine have been put on, he has nothing to do until the machine has drawn out all the milk it can. Usually the teats are then stripped by hand to get out the few remaining drops of milk which the machine cannot draw and which, if left after each milking, tend to shorten the period of the cow's lactation.

Milking machine outfits are, of course, made in many different sizes. Small portable ones on a hand-barrow can be used in cowsheds not fitted up in any way for machine milking. Larger portable outfits, to be drawn by horse or tractor, are used in the open-air bail method of cow management which keeps the cows out all the time on the fields that they are to graze and to manure. Large, elaborate, specially equipped milking sheds have a permanent structure of air tubes and milk tubes to each stall, and the milk as it passes to the cooler and churn is made to record automatically the yield of each cow.

Sterilizing.

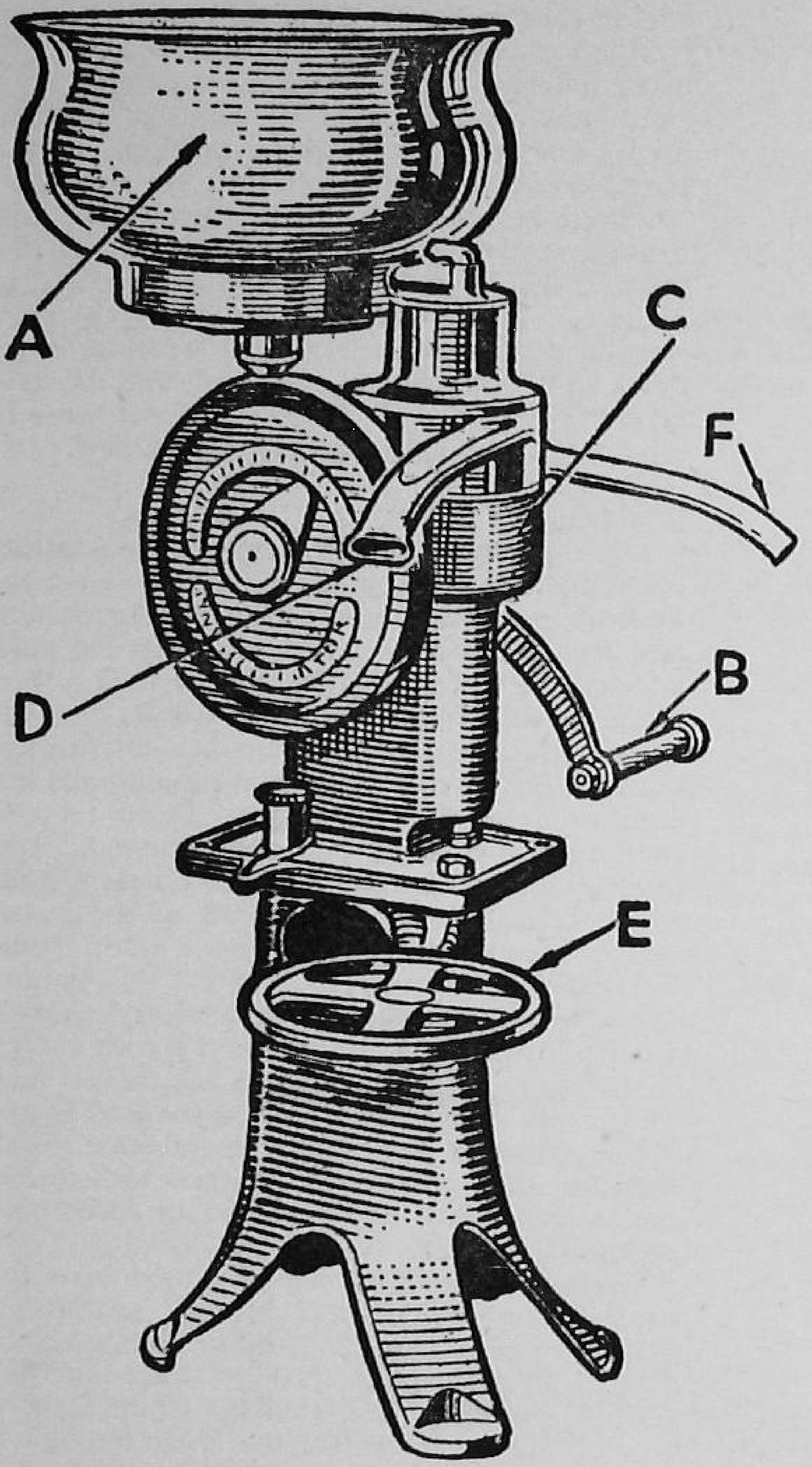
Milking machines are perfectly satisfactory provided they are kept clean, and therefore the most important accessory to the milking machine is a means of washing and sterilizing the parts which have been in contact with milk. Preliminary washing of the machine is done by drawing water, cold at first, and then hot, through the machine. With the suction running, the teat cups are placed under water. From time to time they are lifted out and replaced. This interruption in the flow of water causes a surge which helps the cleaning action of the water. Next some method of sterilizing is used. Some workers blow steam through the teat cups without dismantling them; some use a chemical detergent; others dismantle the teat cups and put the rubber liners into a hot chest. When a hot chest is used the rubbers must not be left in the metal teat cups, nor must they be in contact with any other metal, since heating rubber in contact with metal causes the surface of the rubber to decompose and become sticky.

Sterilizing chests, which are used also for sterilizing other parts of the milk equipment, have to be capable of maintaining a temperature of 210 degrees Fahrenheit in their interior. Usually the chest is heated by steam from a boiler. The steam enters the chest through a perforated false floor. Some electrically-heated chests, however, used to have the heating elements actually around the walls of the chest.

Coal, or oil, or gas, or electric-fired boilers are used. They need only operate at about 5 lb. per square inch pressure of steam. The pipes, and the chest itself, are well lagged to insulate them against loss of heat by conduction and radiation.

Cooler.

Milk from the cow is at a temperature of about 85 degrees Fahrenheit, and it must be cooled down quickly to about 40 degrees Fahrenheit if it is to have good keeping quality. If plenty of cold water is available, the milk can be cooled by allowing it to flow over a battery of copper pipes through which the cold water is passing. With this kind of cooler the temperature of the milk



A CREAM SEPARATOR

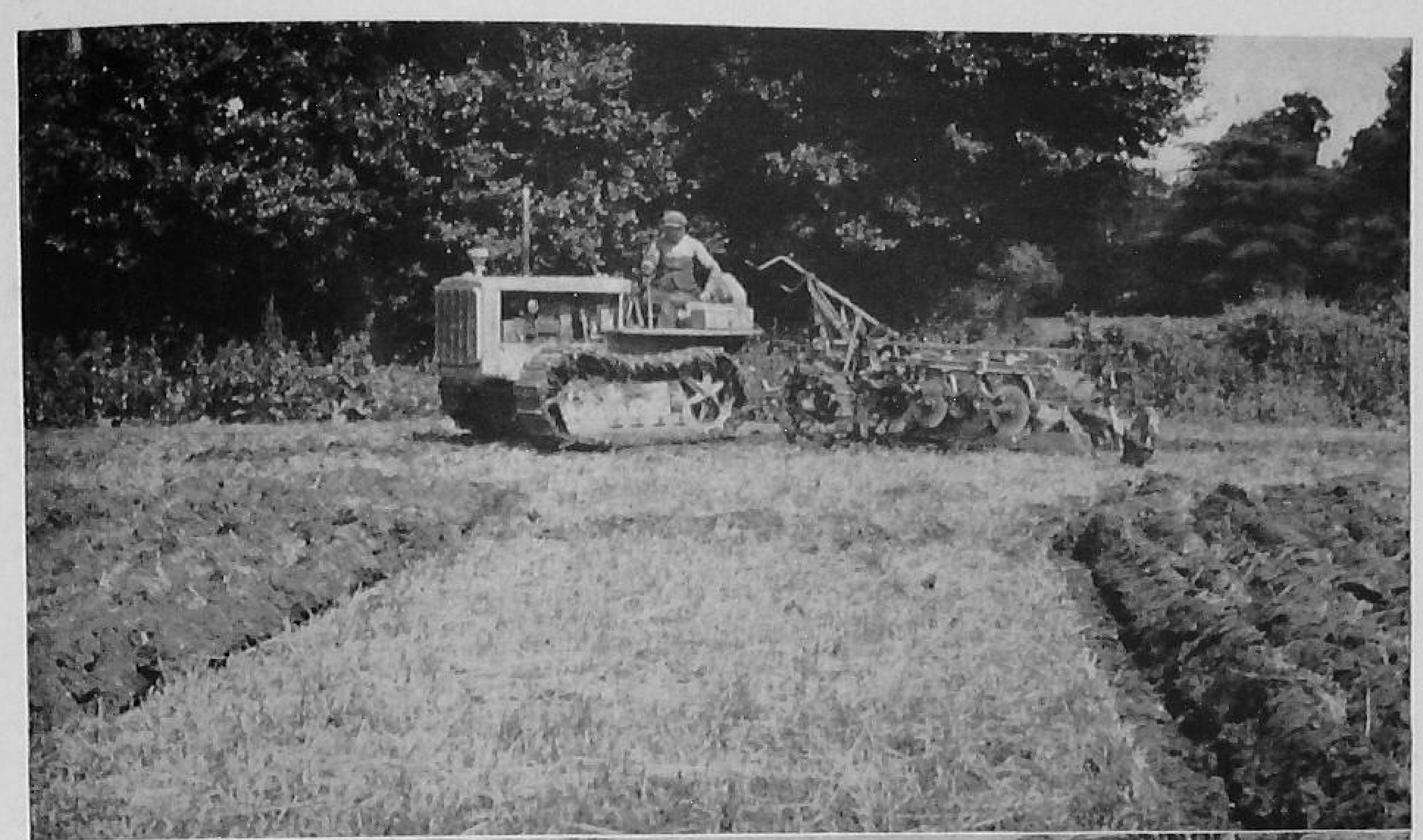
The whole milk is poured into the hopper, A. The handle, B, drives through a train of gears and causes the spinning bowl, in compartment C, to rotate at a very high speed. The cream flows out of pipe D into a can placed upon the stand E. The skimmed milk flows out of pipe F. A bell rings when the handle is being turned at too slow a rate. As soon as the correct speed has been reached, the mechanism of the bell is thrown out of action. The flow of milk from the hopper into the spinning bowl is controlled by a float-operated valve, like the valve in the float chamber of a motor engine carburettor, so that a constant head, or level, of milk is maintained in the bowl chamber. The bowl has a conical lid, and inside the bowl is a pile of conical plates, each plate being separated by about a sixteenth of an inch from its neighbour. Therefore, when the milk enters the bowl through apertures in the hollow central tube, it gets divided up into conical layers a sixteenth of an inch thick. These thin layers react quickly to the centrifugal motion, and the skim milk moves outwards and escapes round the edges of the plate into the outlet F. The cream moves towards the centre of the cones and meets the incoming whole milk. The pressure of this incoming flow forces the cream upwards to the top of the inside of the central tube. Then the cream passes through the hollow screw of the adjusting jet which projects into the space in the centre and flows out of pipe D. The lightest part of the cream, and therefore the richest and thickest part, comes to the middle of the central space. Therefore the more the opening of the jet is constricted to the middle of the central space, the thicker is the cream and the smaller is its quantity.

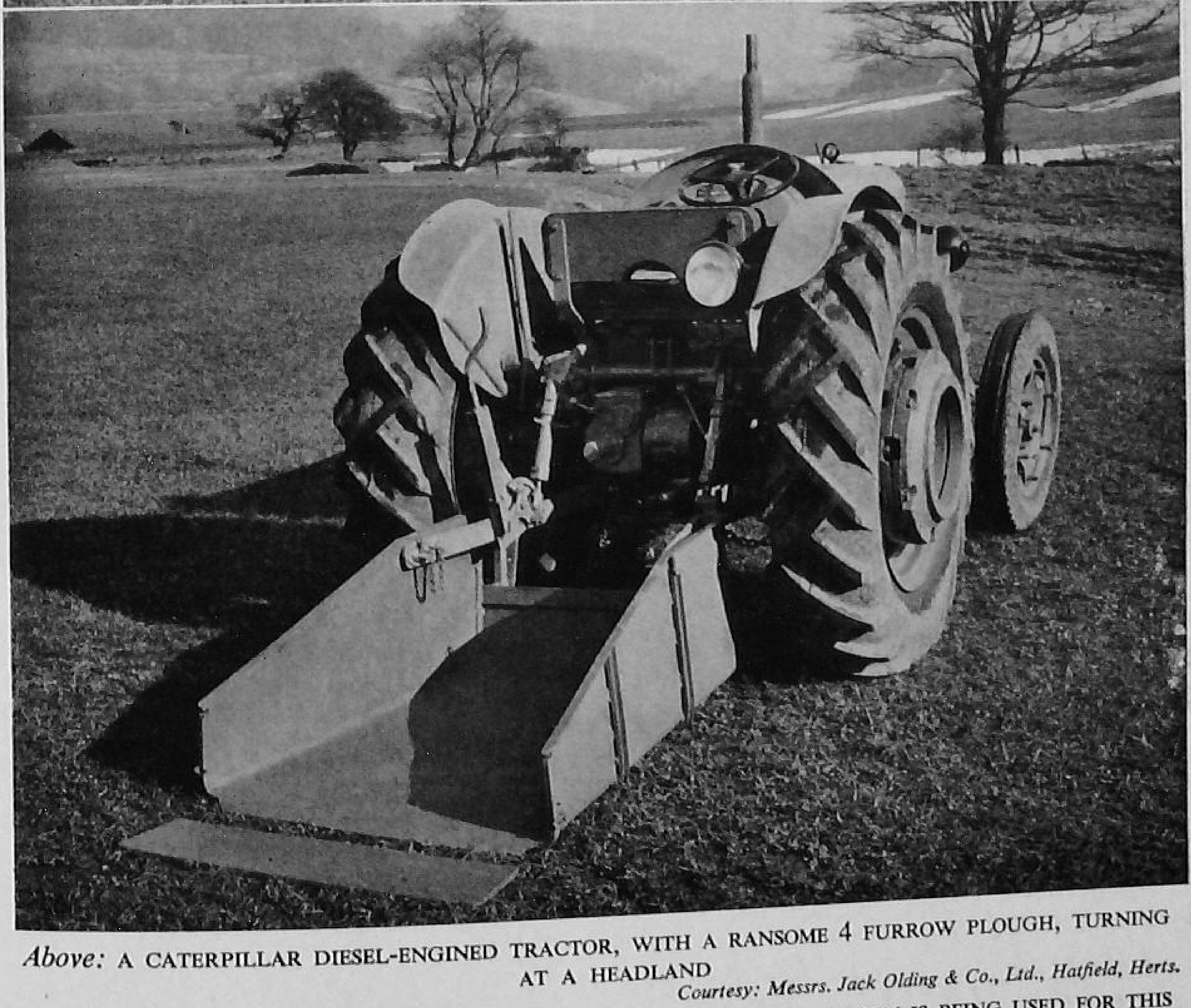
cannot be brought down to nearer than within 5 degrees Fahrenheit of the temperature of the water. In summer, unless the water is coming from some deep, cool well, this method of cooling is not good enough, and a chemical method of obtaining a low temperature has to be employed. The kind of refrigerator generally used for this work is a machine for compressing some gas which will readily liquify under pressure. Heat is developed in the compression, and that heat is cooled away by water, but the water used need not be very cold. Then the liquified gas is allowed to expand and pass again into its gaseous state. In this second change the heat which was given off in the first change and handed to the water is now required back again. This heat is now taken from the milk which it is desired to cool.

Cream Separator.

The operation of the mechanical cream-separator depends on the facts that cream is lighter in weight than is skimmed milk, and that when a composite liquid is centrifuged, its heavier parts move towards the periphery of the spinning vessel, and displace the lighter parts by urging them towards the centre.

The spinning vessel in the separator is in the shape of a bowl, and it rotates at a very high speed, about 8,000 revolutions a minute. The bowl must be well balanced and it must run on a very smooth bearing, otherwise it will vibrate, and a vibration at this high speed gets worse and worse and can become dangerous. On some models, the vertical spindle of the bowl is supported on ball bearings, a guide bearing and a

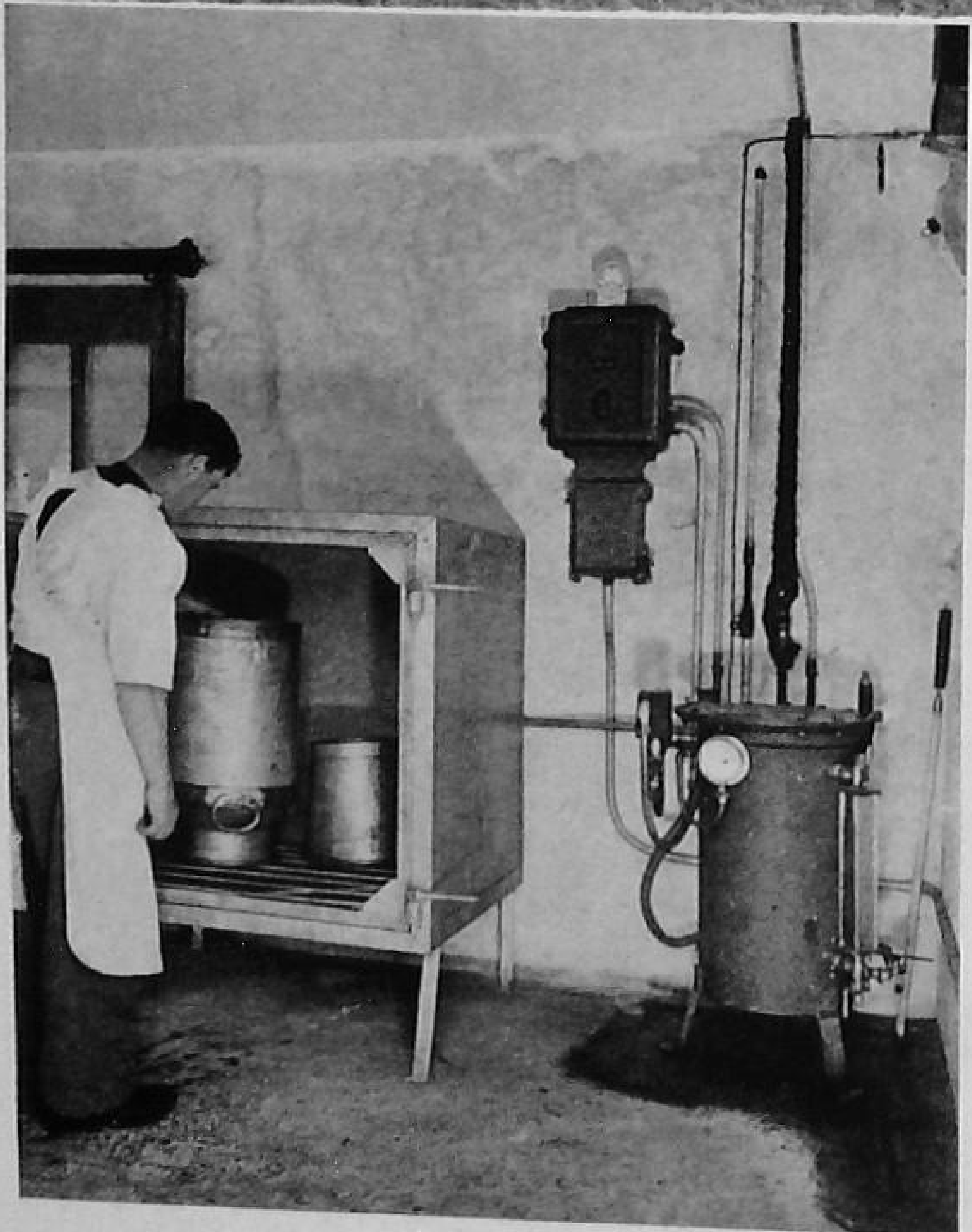




Above: A CATERPILLAR DIESEL-ENGINED TRACTOR, WITH A RANSOME 4 FURROW PLOUGH, TURNING AT A HEADLAND

Courtesy: Messrs. Jack Olding & Co., Ltd., Hatfield, Herts.

Below: ON THIS DAVID BROWN TRACTOR, THE HYDRAULIC LIFT MECHANISM IS BEING USED FOR THIS CARRIER BOX WHICH WILL TAKE A 6 CWT. LOAD. THE BOX IS LIFTED OFF THE GROUND BEFORE THE TRACTOR IS MOVED



Above: AN ALLMAN SAWBENCH DIRECTLY ATTACHED TO A FORDSON TRACTOR WHICH CARRIES IT TO ITS WORK AND THEN DRIVES THE SAW-BLADE.

Left: A STERILIZING CHEST HEATED BY STEAM FROM AN ELECTRIC STEAM-RAISING BOILER.
Courtesy: Messrs. The General Electric Co. Ltd

thrust bearing. On others the bowl is suspended from a cord.

The separation of the cream from the milk is helped by the bowl being divided into many compartments by conical plates.

Cream collects in the top of the centre of the bowl and flows out through a kind of jet, large and adjustable. If this jet is screwed up so that the only outlet is from the extreme centre of the tube, only very pure cream can come out. If the jet is opened out a little, the cream has more milk mixed with it. This is an adjustment to be made by the operator according to the grade of cream desired. The skimmed milk passes out of the edge of the bowl into a delivery pipe.

CARE AND MAINTENANCE OF MACHINES

Machinery makes farm work easier and pleasanter. Ploughing by tractor is better than digging with a spade, and milking by machine takes much of the hard labour out of dairy farming. In return, the worker has to maintain the machinery in good order and keep it free from unnecessary wear.

Rust.

IRON is the metal chiefly used in field implements, and therefore careful watch has to be kept against rust. Some of the parts can be protected by paint, but many of them are moving parts. Either they move through the soil, or their surfaces make rubbing contact with the surfaces of other parts of the implement. So paint would not remain on them. For instance, the mouldboards of ploughs become brightly polished during their work of turning over the slice of soil that has been cut by the share. If the plough is left uncared for overnight in the field, the board is red with rust in the morning. The mould-roughness of the rusty surface prevents the soil sliding smoothly; the furrow slices will not fall right over, and the ploughing will look bad and will be inefficient because the vegetation will in some places be left too near the surface.

After several bouts of work the mouldboard will have polished itself again by friction with the soil; but those first few untidy bouts in the morning spoil the field, and, also, the rusting and re-polishing takes away a layer of the mouldboard and hastens its wearing out. The rusting of the mouldboard can be prevented by painting the mouldboard with used oil discarded from the sump of a tractor engine, or, better, with one of the special rust preventing compounds that can be bought ready made up.

Oil.

Not only plough boards, but the bare iron or steel surface of all other implements should be protected by oil or compound when the implements are out of work. For example, the gear-wheels and levers on seed drills and manure distributors cannot work smoothly if their iron-to-iron bearing surfaces are rusty, and they ought to be coated with rust preventing fluid when the machines are put away for next season.

Dirt.

Dirt is fairly harmless as long as it is only on the outside of machines and implements. A spotlessly clean tractor is pleasant to look at, but it really is no more efficient than one covered in oily mud, though the clean condition may make easier the very important job of looking over the machine to see whether any parts have become loose. But if there is an accumulation of dirt in the air cleaner of the carburettor of the tractor, or if there is grit in any of the bearings, the brightest of polish on the outside of the machine cannot save the operator from trouble to come.

Lubricant.

Oil as a lubricant prevents machinery from wearing out quickly and, what is perhaps more immediately important to the operator, it makes the work of using the machine easier. But the beneficial action of oil can never be at its best if dirt also is present. Clean oil forms a film between bearing surfaces and makes them slide easily over one another without wearing out, but oil and grit mixed together make a grinding paste which will cause the bearing to wear out faster than it would if there were no oil present at all. This is truer of metal-to-metal surfaces than of some other combinations of surfaces, and we have seen in a previous section how wood-lined bearings are used in some places where the entry of grit is inevitable.

Grit.

Many bearings are fitted with seals against grit, but sometimes bearings have to be taken to pieces and dirt gets into them when they are being put together again. Sometimes, too, when bearings become worn, there is room for the seal to move away from the housing of the bearing and leave a gap through which dust can enter.

Greasing.

The only way to get rid completely of dirt in a bearing is to take the bearing to pieces when the implement is in a shed, and clean them with paraffin. But in bearings that have grease-gun lubrication most of the dirt can be cleared out in the process of greasing.

The first few strokes of the gun do not produce any effect that can be seen by the user, but when the space in the bearing housing fills up, grease starts to exude around the edge of the bearing. At first the grease that comes out is hard and dirty, but if the pumping of the gun is kept on long enough all the old grease will be turned out, and new grease will begin to exude. Much of the dirt will have come out with the old grease.

Adjustments.

Cleaning and lubricating are the usual tasks of regular maintenance work, but sometimes adjustments also have to be made, and occasionally worn or broken parts have to be replaced. The following notes indicate the kind of attention that implements and machines have to receive.

Shares.

The shares of ploughs have to be replaced when they are so worn that they lose their edge and penetrating power. The share fits, like a socket, on to a nose or projection in front of the mouldboard. It is held in place only by a wooden pin driven through a hole in the share aligned with a hole in the projection. The share is kept in place by the working of the plough; the wooden peg merely has to keep it on while the plough is out of work. A wooden peg, instead of a metal pin, is used as a safety measure. If a tractor plough, is for any reason, driven backwards

while its bottoms are down in the soil, the wing of the share is very liable to be broken off if the share is too rigidly attached to the nose of the mouldboard. If the wing of the share meets a serious obstruction while the plough is being backed, the wooden peg breaks, before any damage can be done.

If a share has come off, the plough must not be allowed to go on running without it. The flow of soil over the exposed surface of the nose of the mouldboard body quickly wears the nose so that the socket of the share is no longer a snug fit on it. A loosely fitting share is always troublesome. If packing is inserted to tighten it, it must be put in underneath and not on top. But a packed-up share is rarely correctly positioned. The only real cure is to have the worn nose carefully made up to its original shape by welding.

Play.

Play in the wheel bearings of some ploughs can be taken up by adding spacing washers to move the bearing farther up the tapered shaft of the axle. Play in the bearings of disc coulters does not matter very much, as long as the discs can rotate freely. Discs have to be replaced when their diameter has become so much reduced by wear that they cannot be set deep enough to cut the slice without the hubs of the discs riding on the surface of the land and so hindering the penetration of the plough.

Distortion.

The beams of multi-furrow ploughs sometimes get bent. This distortion usually takes place in a way that throws one of the plough bottoms out of position relative to its fellows. The plough cannot make uniform furrows until this body has been brought back into its right place.

The bent beam can be straightened by a blacksmith, but usually, when this has been done, the place that has been bent and re-bent is weakened, and the beam is likely to bend again in the same place.

Often it is possible to compensate for small distortions in the plough frame by changing the adjustment or place of attachment of the various components: For example, on most ploughs each bottom is individually adjustable for pitch, either by means of a threaded pin already provided for the purpose, or by the insertion of steel wedges. To correct for-and-aft alignment, packing washers can be added to bolts to bring bracket into a new position, and thin metal plates can be used to increase the separation where beams are clamped together.

Mowing Machines.

In the case of mowing machines the most frequently replaced part is the knife, that is the series of knife sections which make up the cutting member. A newly-sharpened knife is needed every two hours of work if the cutting of the grass is to be done well. It is usual to have a spare knife back, complete with newly sharpened sections, ready to change for the old one, so that the machine shall not be out of operation while the sharpening is going on. The two edges of the triangle of each section are sharpened by filing them so that the original slope of the bevel of the edge is restored. The angle of the sides of the triangle must be maintained the same as it was when the sections were new. When the sections have been sharpened so many times that they have become too small, they must be renewed. They are riveted on to the knife back.

Reaper-and-Binders.

In reapers-and-binders too, the knife has to be kept sharp, though a blunt knife will cut the brittle stems of corn better than it will cut juicy grass. The canvases of the moving belt system of the binder, and the many driving chains, must all be kept correctly adjusted, and the springs and levers which control the journey of the twine through the machine must be set so that they impart the desired tension to the twine at the various points of its travel.

The great aim in preparing the binder for work is to ensure smooth running. Vibration and sudden shocks upset the action. That is why, for instance, it is so important to keep the knotter hooks brightly polished and the twine-cutting knife sharp, and why the canvases must always be put on to the rollers in such a way that the strap ends will not cause a bump as they go round; they should run with the buckles of the strap leading.

Internal combustion engines, on the tractor, on combine harvesters, and for driving elevators and barn machinery, need to be decarbonized from time to time, and to have their valves ground in so that the cylinders shall remain gastight.

Long and Useful Life.

We have already seen that on most machines the wearing parts, such as the knives on root cutters and chaff cutters and mowing machines, and the hammers or plates in mills, can be replaced when they are worn down beyond the limit within which they can remain efficient. It can be said that apart from making necessary replacements, the care needed to give machines a long and useful life lies in protecting them from rust and grit and in making adjustment to compensate for the effects of wear. For example, a slack bearing should not be allowed to go on being slack. The slackness causes vibration and the vibration causes the bearing to wear quickly worse and worse. Moreover, other parts of the machine will soon begin to suffer through the looseness of that bearing. A single part of a machine cannot live for itself alone, it is part of a corporate body. If wear in any one part of a machine is causing the misalignment of other parts—and it usually does—those other parts cannot work smoothly and they will soon wear out.

THE FARM MECHANIC

Our author defends the farmer from some unjust criticisms and praises the efficiency of farm machinery as a whole. He discusses the personification of machines by those familar with their use and thinks it is not altogether a bad thing for a farmer to look upon his machine as his friends!

Agriculturalists and Mechanics.

HAVING read this book thus far, the reader may begin to think that a good farmer needs to be a skilled mechanic rather than a skilled agriculturalist. But that idea is wrong. The farmer and his men need to be both agriculturalists and mechanics, but primarily they need to be agriculturalists. During the war, the number of tractor ploughmen had to be increased very quickly. Much of the increase came from two sources, from horse-ploughmen who had to learn how to use a tractor, and from people who had never done any ploughing but who were experienced motorists. In the latter category were many members of the Women's Land Army, and it is no discredit to the wonderful service these girls rendered, to say that it took them very much longer to become ploughmen than it took the horse-ploughmen to become tractor drivers. Ploughing needs a knowledge of the soil that can come only from recording in one's mind the behaviour of the soil in all its conditions; from remembering how it behaved, and had to be treated, on days when it was so sticky that it would not scour off the face of the mouldboard and on days when it was baked so hard that the plough-share had to be given a special tilt to make it penetrate at all. And, somehow, this knowledge of soils and of animals, helps the farm worker to humour his machinery into giving out its best work.

The view is often expressed that farmers do not look after their machinery as well as workers in other industries do. But that view is not supported by facts. There are many reaper-binders still at work after thirty years service. The binder, as we have seen, is a very complicated machine, and although it is used for only a short period each year, it does get very hard work during that short period, and, moreover, the long non-working period give plenty of chance for deterioration by rust.

Machines Need Attention.

The fact is that farmers do know which parts of their machines need attention and which parts will carry on without attention although they would look better for having it. Farming is a busy life, and no sooner is one seasonal operation over than a new one comes along, and so the farmer cannot give the machine he is putting away all the cleaning and polishing he would like to give it. But usually he does everything that is really necessary.

The Critic.

Often, the critic of the farmer's ways of looking after machines is quite wrong. For example, an onlooker, used to tending machines in a factory, may be shocked to see that the chain drive on some land implement is being run quite dry of oil. But this is not because the farmer has forgotten to oil it; he knows that an oil covered chain, working in a cloud of soil-dust, picks up abrasive particles which mix with the oil and cause the chain and sprockets to wear out much more quickly than if they were running dry.

Personality.

In one matter, however, we people who have to work farm implements are wrong, or at any rate unscientific. We are apt to credit machines with personality. We begin to believe that machines have days of being in good moods and days of being in bad moods, days of running smoothly, days of being awkward. Many of us can tell of occasions such as that on which an unreplaceable casting on the old mower broke at the end of the very last round in the very last field at hay-making time, and praise the old machine for carrying on until the job was finished. We point out that if the mower had let itself crack up in the middle of the cutting, much of the grass would have gone past its best stage before a neighbour could spare a machine on loan to help us out.

On the other hand, machines that do go wrong often get sworn at and rebuked.

Living Material.

Now, no doubt this imputation of a will to a machine, as though it were a horse, is foolish, and no doubt statistics could show that just as many mowers break down at the beginning of a job as at the end of the job. Yet it must be remembered that when you consider a farm machine you have to consider not just the machine, nor just a machine plus some raw material of well defined properties such as an ingot of steel. What you have to consider is the machine plus some living material such as soil or corn or grass, which has moods which change with every variation in the weather, the season and the time of day. An old racketty binder may make a good job of harvesting corn that has just the right amount of moisture in the stems to make them cut cleanly and pack neatly into the buncher. A brand new binder may give trouble in a crop of awkward condition. It is therefore not to be wondered at that the machines themselves come to seem to have moods.

Your Friend.

Moreover, the effects of the fiction, if it is a fiction, are all to the good. A thing you look upon as your friend is more likely to be treated well than is a mere mass of iron bars and nuts and bolts!

To close this section on a defensive, or perhaps offensive, note, it may be said that many of the people who laugh at the farmer's repair methods and say that he knows only one tool, the hammer, and one jointing material, binder twine, would find difficulty in equalling his extemporary repairs even if they had a whole kit of elaborate tools to help do the job.

THE FUTURE

Finally our experienced agricultural engineer looks ahead. He has a vision of the need and pictures the likely trend of future development, He expects an increase in so-called "market-garden" crops with an increase in ingenious devices for dealing efficiently with the problems that will thus arise.

He discusses the future of field power: improvement in the grip by wheels and tracks is likely to be made, and traction may come to be regarded as the wrong way of applying power to implements and a new—not the old—method of using cable may arise. The use of electricity receives detailed consideration both in this connection and in other ways on the land. In some things the agricultural engineer must wait for other agricultural scientists to reach conclusions before his work begins in other cases—he cites the mechanized handling of dung as an example—the problems of to-day may pass with advances in agricultural practice.

Prophecy.

In a book which started with hand tools and a note on the development of agricultural machinery through the ages, it would seem proper to end by a prophecy of future trends in farm mechanization. But that is difficult.

What is certain is that the aim of development will always be the elimination of hand labour. That may mean that fewer workers will be needed on the land; but it may mean instead, that the land will be cultivated more intensively, and that the same number of workers will be able to produce more food from a given acreage of land, and that that food will be better in quality. This will probably come through a reduction in the acreage of cereals, and an increase in the acreage devoted to what we now call market-garden crops.

Market-Garden Crops.

Market-garden crops are higher in feeding value per acre. One reason for this is that more than one crop can be grown on the same piece of land each year. Also they are usually of the type rich in vitamins, the protective foods. Market-garden crops, however, need much labour for every acre. On many gardens, planting, weeding and picking are done by hand.

It may seem strange that mechanization has been applied more completely to field crops than to garden crops. The reason is that the problem was simpler. Crops like corn can be treated as masses; plants like lettuce need individual attention, and the problem in mechanics entailed in making an implement to look upon each plant separately is a hard one.

Individual Plants.

We have seen that transplanting can now be done quite satisfactorily by machine. Inter-row hoeing also is being done accurately by machine. Machines for hoeing between the individual plants of the row have been designed and made and are being improved. Machines for picking fruit and vegetables have so far eluded the ingenuity of designers. Anyone who has cut green vegetables on a frosty morning in time for a consignment to be sent to shops to be sold that day, will know how the ice on the leaves and stems treats the fingers, and he will welcome the success which is bound to come in the end to the inventors who are making the mechanical gathering of garden crops their aim.

Transmitting Power.

To generate the power for field operations we rely now on the motor tractor, and are likely to do so for many years to come. At present the paraffin engines with which most of our tractors are equipped are efficient and trouble-free. Compression-ignition heavy-oil engines are even more efficient and just as reliable, and they may become the popular internal combustion engine for the tractors of the near future. We saw, however, that a limiting factor in the use of a tractor of any sort is the grip of its wheels or tracks. No doubt the grip of wheels and tracks will be improved.

But in the end it may be decided that traction is the wrong way of transmitting power to implements, and we may go back to some modification of the old cable cultivation system which was the method first used for applying power to arable farming. We shall not, however, ever use that kind of steam-engine to work the winches for the cable. Too much valuable time had to be spent in carting coal and water for the engine, and in moving the outfit along the headland to do the next bout of work. The coal and water-carting bogey has been done away with already in some of the few remaining sets of cable tackle; the steam-engines have been converted to Diesel heavy-oil engines. All that is needed now is to find some method of arranging the pulling in and paying out of the cable other than having either a fixed engine at each side of the field, or one fixed engine and a fixed anchor. When that has been done, the day of the tractor for heavy cultivation work may be over, and the new method may at the same time at last give us a convenient way of using electric motors for field cultivation work.

More Uses for Electricity.

The chief benefit so far brought to farms by an installation of mains electricity is good lighting; and this itself is indeed a blessing. On winter mornings and evenings powerful bulbs can flood the whole cattle-yard with light and make the worker's job twice as easy as it was when he had to carry a hurricane lamp. But it is inevitable that more and more uses for electricity will help agriculture in the near future. Some of those ways of using electric power are already being

tried experimentally or are actually in operation on a few highly-mechanized farms. Of those already in use we can mention power for driving barn and dairy machinery; steam raising and direct heating for sterilizing dairy equipment; the heating of glasshouse soil, either to a high temperature to kill off bacteria and fungi harmful to vegetable growth, or to a maintained moderate temperature to promote growth of plants; the heating of the air in glasshouses; the providing of thermostatically controlled heat for poultry brooders and egg incubators; and the providing of heat and light in laying pens. Uses which are still in the experimental stages include the artificial drying of hay and other crops; the electrolytic treatment of seeds to improve their yield; ultra-violet irradiation to help the growth and health of poultry and cows; and the electrical treatment of greenstuff to make silage.

Electric Fence.

The electric fence, though usually this works from a battery and not from a mains supply, is greatly helping some forms of alternate husbandry by providing a quick and cheap way of confining stock, temporarily, to some particular patch of land. A single wire, mounted on insulators fixed to light fence posts, carries a small current at about 100 volts at a frequency of about 50 interruptions per second. Animals standing on the ground and touching this wire receive a shock sufficiently sharp to cause them to keep away from the wire.

Ploughing.

The application of electricity to ploughing and other field operations has, however, so far not been carried out efficiently in Britain, though various forms of it are successful practice in compact farms on the continent of Europe. On these farms electric tractors are the usual method of applying the power, and the supply conductor wire is trailed behind, kept taut by a spring loaded bobbin. A suggested alternative is to lead the supply of electricity to an overhead network of trolley wires from which the tractor can pick its supply through a vertical feed arm.

Cable Operation.

To return to the discussion of cable operation as a general principle for field cultivation, we can note the possibility that such a method might be made nearly automatic in action.

Even now, using a big tractor and a plough of many mouldboard bottoms, we have achieved a very low man-hours per acre for ploughing, particularly where the fields are big enough for round-and-round ploughing to be done instead of the more usual ploughing in rigs and lands; and in America now tractors and ploughs are being sent off round the fields with no man sitting on the tractor at all. In front of the tractor are little dished wheels which press against the wall of the last furrow that was cut on the previous bout of the outfit. These dished wheels are connected with the steering gear of the tractor in such a way as to keep the outfit on its course.

That certainly is going a long way towards getting the land tilled by machines instead of by men. But experiments are now being conducted to find a method which will allow an operator to be in control of every part of the cultivation, even the intricate operations of small area work on rowcrops, but the control will be remote control.

Radio Waves.

The tractor, or self-propelled implement, will be directed from the headland through the medium of radio waves. Perhaps eventually the machine will be steered to perform its job on each individual plant, by an automatic feeling device working on the same principle as Radar.

Many future developments in machinery will wait upon developments in other branches of agricultural science.

Specialized Machines.

We have talked a little of the present machines for applying chemicals to the land, but as selective weed-killing chemicals are further developed, more and more specialized machines will be needed for applying them.

The extreme telescoping of operations one into the other to save time and labour must not be attempted without knowing how far it will depress yields per acre. We must know whether the traditional sequence of operations in tillage, with the traditional elapse of time between each operation, is necessary and right. If it is found that the only preparation soil needs before seed is planted in it is a thorough pounding and stirring, then we already have rotating-tine machines that can do that in one operation. Even if it is found that all the fertilizer soil ever needs can be applied in the form of a powder, agricultural engineers will not be relieved of having to go on investigating one other problem which, like the complete harvesting of root crops, is proving a hard thing to solve; that is, the mechanized handling of dung, from cattle byre to field-spreader. For, unless big changes in cattle husbandry, such as the extension of the practice of open-air milking and stock-keeping, do away with sheds, sheds will have to be cleaned and heaps of farmyard manure will have to be moved.

SECTION V

GOOD GRASSLAND

by

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Illustrations by
YOLANDE MASSEY, B.Sc.

INTRODUCTORY NOTE

The first four Chapters of this Section need a general introduction which is here set out for us.

THE PRINCIPAL GRASSES AND CLOVERS.

Importance of Recognition.

IT is not possible for anyone to take a really intelligent interest in grassland until he is able to recognize with certainty at least the commoner plants which make up the herbage. This point is sometimes forgotten by lecturers and demonstrators and others who talk to farmers about grassland, with the result that what they say is often above the heads of their audience. Not every countryman is able to distinguish between such common species as perennial rye-grass and timothy, for example, nor between alsike clover and white clover; and so, because this book is intended, in part at least, for the every-day farmer, it seems logical to start it by explaining in our first four chapters how grasses and clovers are constructed, how they behave, and how they can be recognized by anyone prepared to use his eyes.

THE GRASSES AND THEIR CHARACTERISTICS

In an opening Section the importance of being able to recognize the chief plants growing in Grassland is stated. The author then proceeds to describe in detail the construction of a typical grass, paying special attention to those features which enable the amateur to distinguish the different varieties. Some account is also given of the structure of a grass seed and its method of germination.

CHARACTERISTICS.

A VERY common little grass which grows on paths and waste places serves as a useful introduction to the great grass tribe. It is called Annual Meadow Grass, and since specimens are in flower almost every day of the year there should be no difficulty in obtaining one with a general resemblance to Fig. 1. The roots, one sees at once, are fibrous and very numerous. This is a character shared by all grasses, which never have a central tap root with much smaller side branches as do the clovers and many other plants. The permanent roots of grasses are all thin and fibrous, and they can be produced very freely by the base of the plant if this becomes necessary. If a grass plant is chopped in two, or if half of it is violently dragged apart from the rest by the action of harrows, rootlets are rapidly thrust out from the base of the stem to renew contact with the soil.

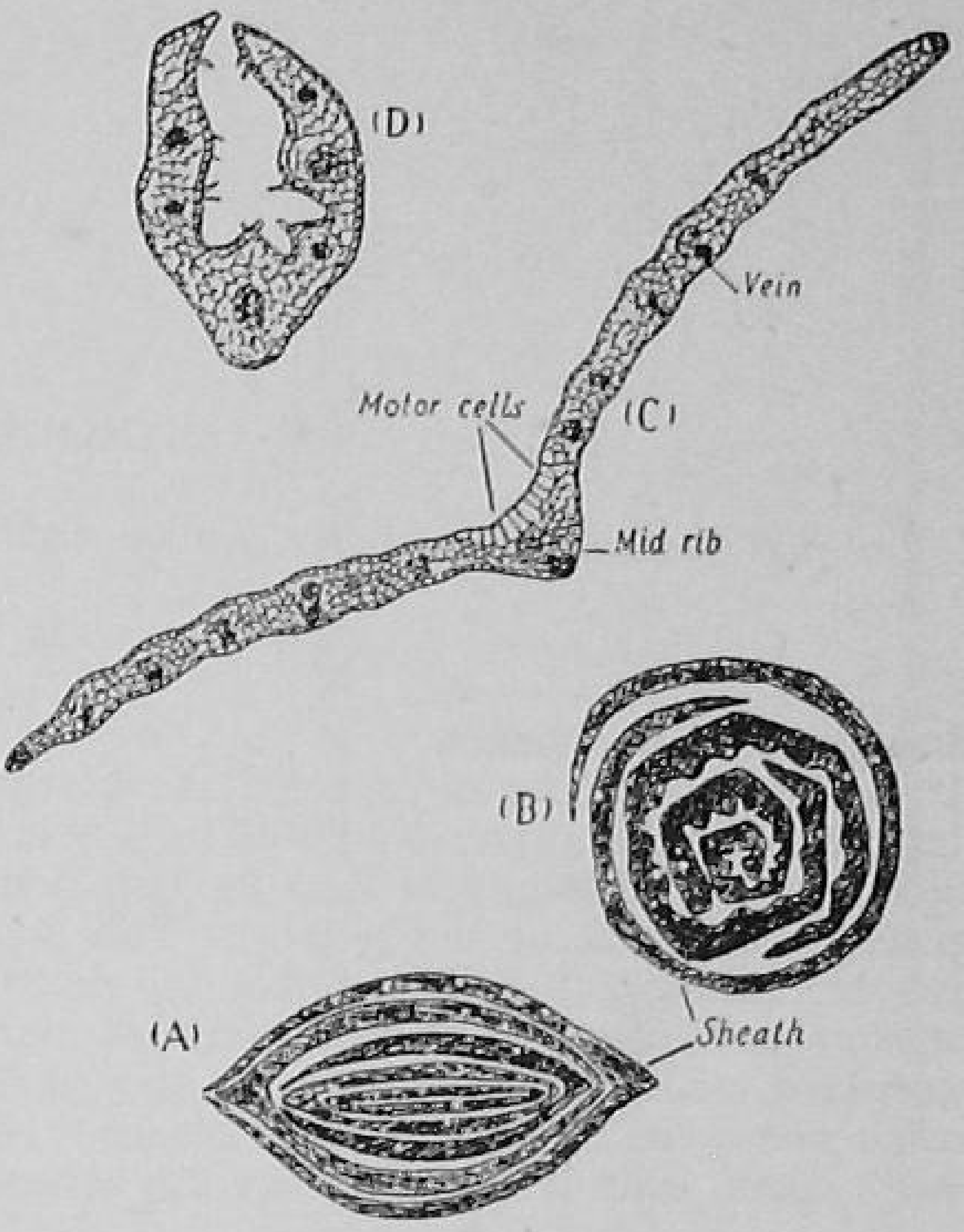

FIG. 2. Cross Sections of the Shoots and Leaves of Typical Grasses.

A. A Flattened Shoot, with folded leaves.
B. A Cylindrical Shoot, with rolled leaves.
C. An Expanded Leaf (Cocksfoot).
D. An almost solid, needle-like leaf (Small Fescue)

This is one of the most characteristic things about grasses, and until the habit is properly appreciated it is difficult to understand their behaviour. The rapid production of fibrous roots explains why some weed grasses are difficult to destroy: it explains in part why the severe harrowing of a turf may lead to better growth. And the general formation of countless numbers of fibrous roots explains to some extent the formation of "turf" and the accumulation of humus in grassland.

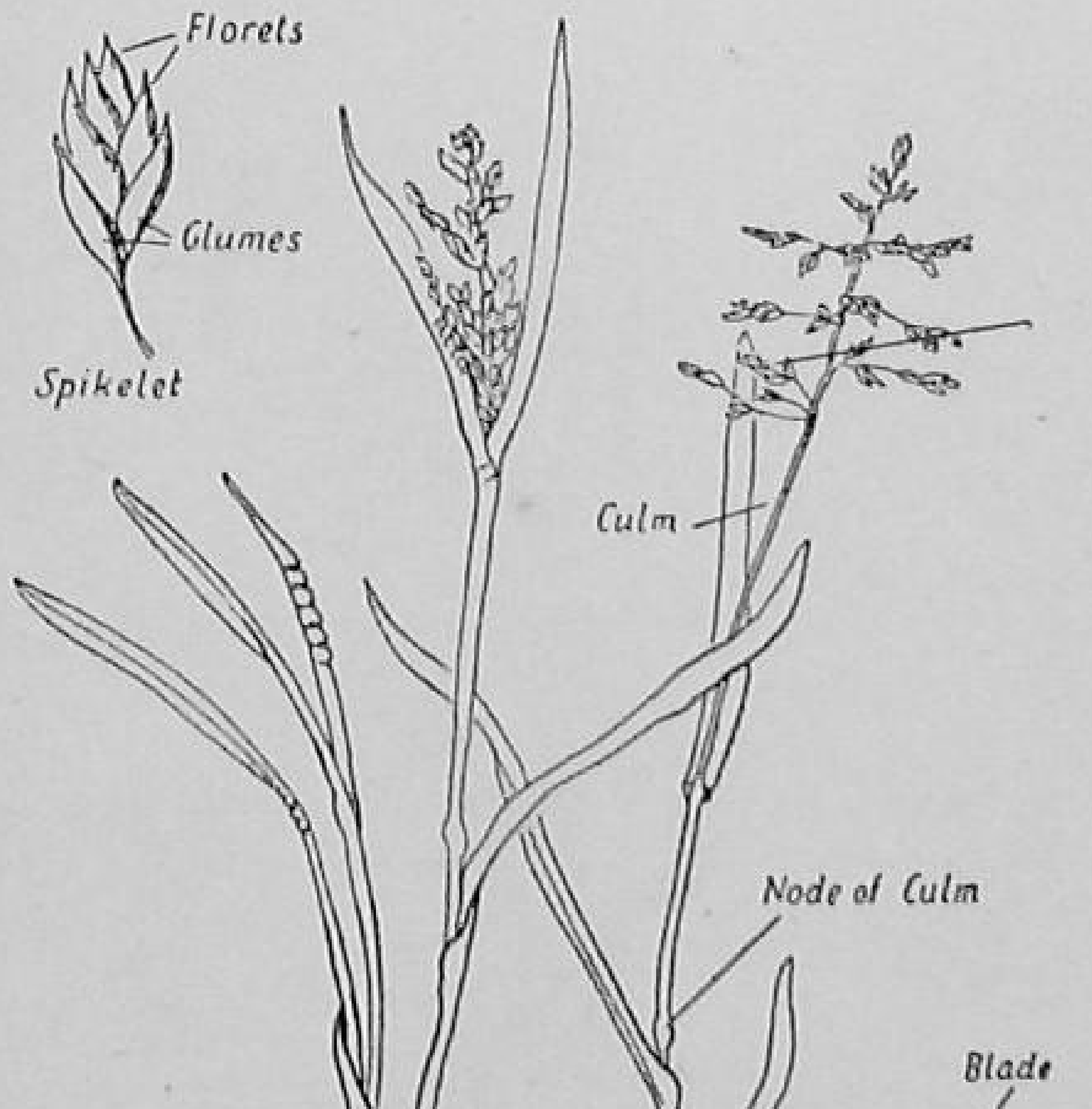

FIG. 1. A Common Grass—Annual Meadow Grass.

The Leaves.

The green parts of a grass consist of the leaves, stems and flower heads. The leaves are the most important part of a grass. They form a large proportion of the food of farm livestock and since it is very desirable to be able to recognize the principal grasses by their leaves alone, it is necessary (and also interesting) to examine a grass leaf with some care.

In the Annual Meadow Grass, a specimen of which should now be in front of the reader, the leaves are folded upon each other to form a flattened shoot. At least the basal portions of

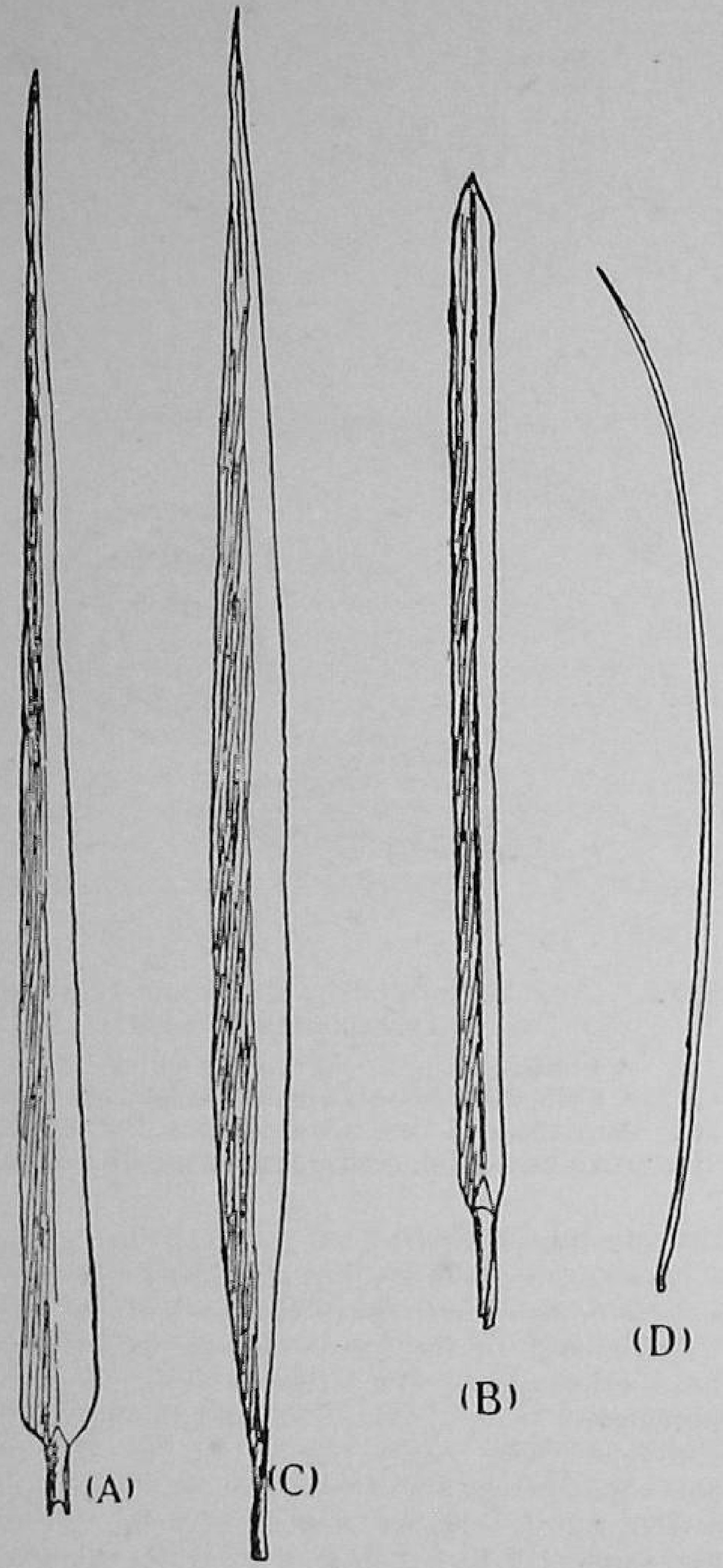

FIG. 3. Leaf Outlines.

A. Tapering to the tip (Cocksfoot and Agrostis).
B. Parallel-sided (Smooth-stalked Meadow Grass).
C. Tapering both ends (Brachypodium).
D. Needle-like (Small Fescue).

the leaves are so folded, while the free ends stand away at an angle from the shoot. The bottom or basal part of the leaf which clasps the stem is called the sheath, and the free part is the blade (Fig. 1).

The fact that the leaf sheaths and leaf blades are folded, so as to form a flat shoot, is important. Only a few of our native grasses have a flat shoot like this Meadow Grass, and consequently it is comparatively easy to recognize grasses with a definitely flattened shoot; the common ones are the Meadow Grasses already mentioned; Cocksfoot; the small Fescue grasses; Crested Dogstail; and Perennial Rye-grass.

Most grasses in this country are so made that the leaf blades are rolled together, giving a cylindrical shoot. Wheat and timothy are examples. Sometimes it is not easy to decide at once if the shoot is definitely cylindrical or flattened, in which case the shoot should be cut across at right angles and the surface examined with a hand lens or magnifying glass (Fig. 2).

It is worth while studying the appearance of the leaf sheaths of grasses, because it is quite easy to recognize certain species by the sheath alone. The example-in-chief is Yorkshire Fog, which has a white sheath streaked with narrow parallel lines which are pink in colour.

The leaf blade is, from the farmer's point of view, the most important part of the plant. It is this part which is chiefly grazed by animals, and good hay should consist chiefly of the leaves as distinct from the stem.

LEAVES ALL DIFFERENT.

When one begins to take an interest in grasses the interesting discovery is made that no two species of grass have identical leaves. At one extreme are the fine Fescue grasses, with leaves which are so solid as to be almost like needles,

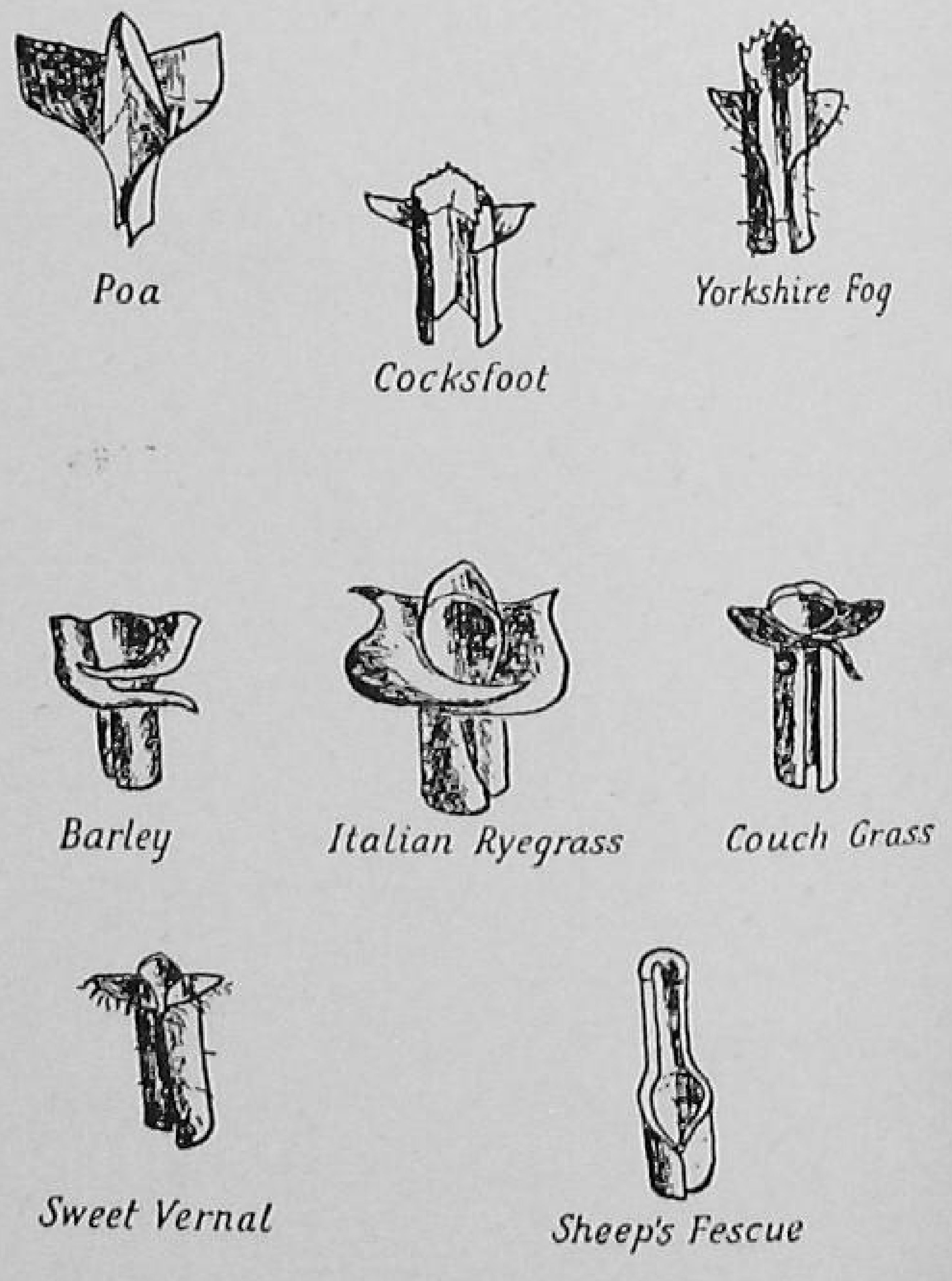

FIG. 4. Ligules and Auricles.

and at the other extreme are species like the Meadow Grasses and Yorkshire Fog, with broad flat leaves (Fig. 3). Some grass leaves taper all the way from base to tip; some expand in the middle before tapering to a fine point; some have almost parallel sides, and so on. Some leaves have very definite ribs running lengthwise along the upper surfaces, others are more or less flat on the upper surface. Some leaves are very hairy, others are smooth.

These may seem to the beginner to be trivial and useless details, but in fact they are important. The student should not try to memorize these characters as they apply to each species. He should pick grass leaves at random and study their features as he walks through fields and lanes; it is remarkable how soon a working knowledge of the differences between species can be gathered in this manner.

At the point where the leaf sheath joins the blade, the inner lining of the sheath appears to project as a thin membrane reaching part of the way around the stem of the grass, rather like a sheet of writing paper partially wrapped round a cardboard tube. This structure (Figs. 1,4) is called the *ligule*. In the specimen of Meadow Grass the ligule is quite easy to see, and it is slightly pointed. In Cocksfoot the ligule is very conspicuous, but in Rye-grasses the ligule is small and insignificant. In other species the ligules have small but definite characteristics.

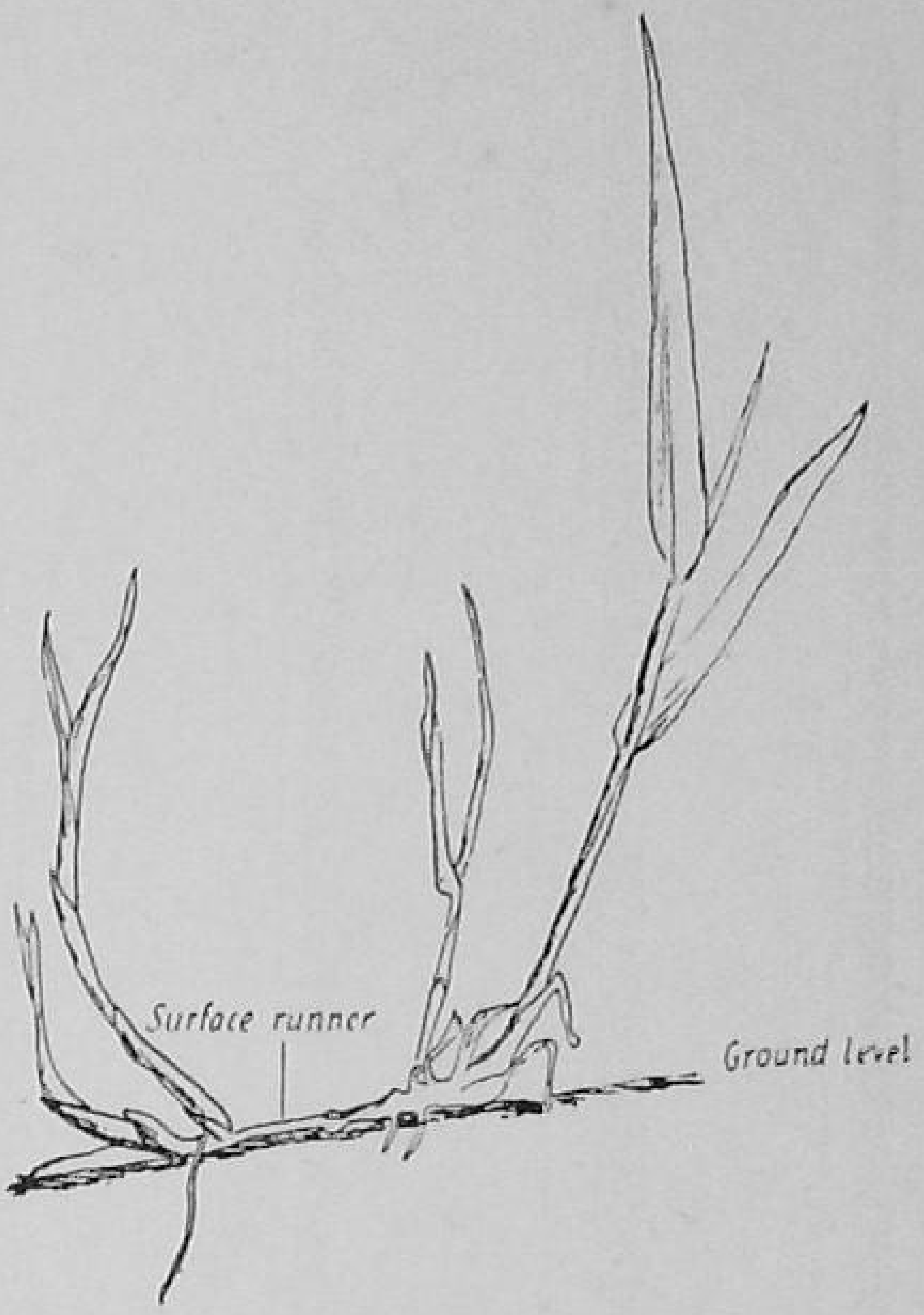

FIG. 5b. Surface runner of Bent grass.

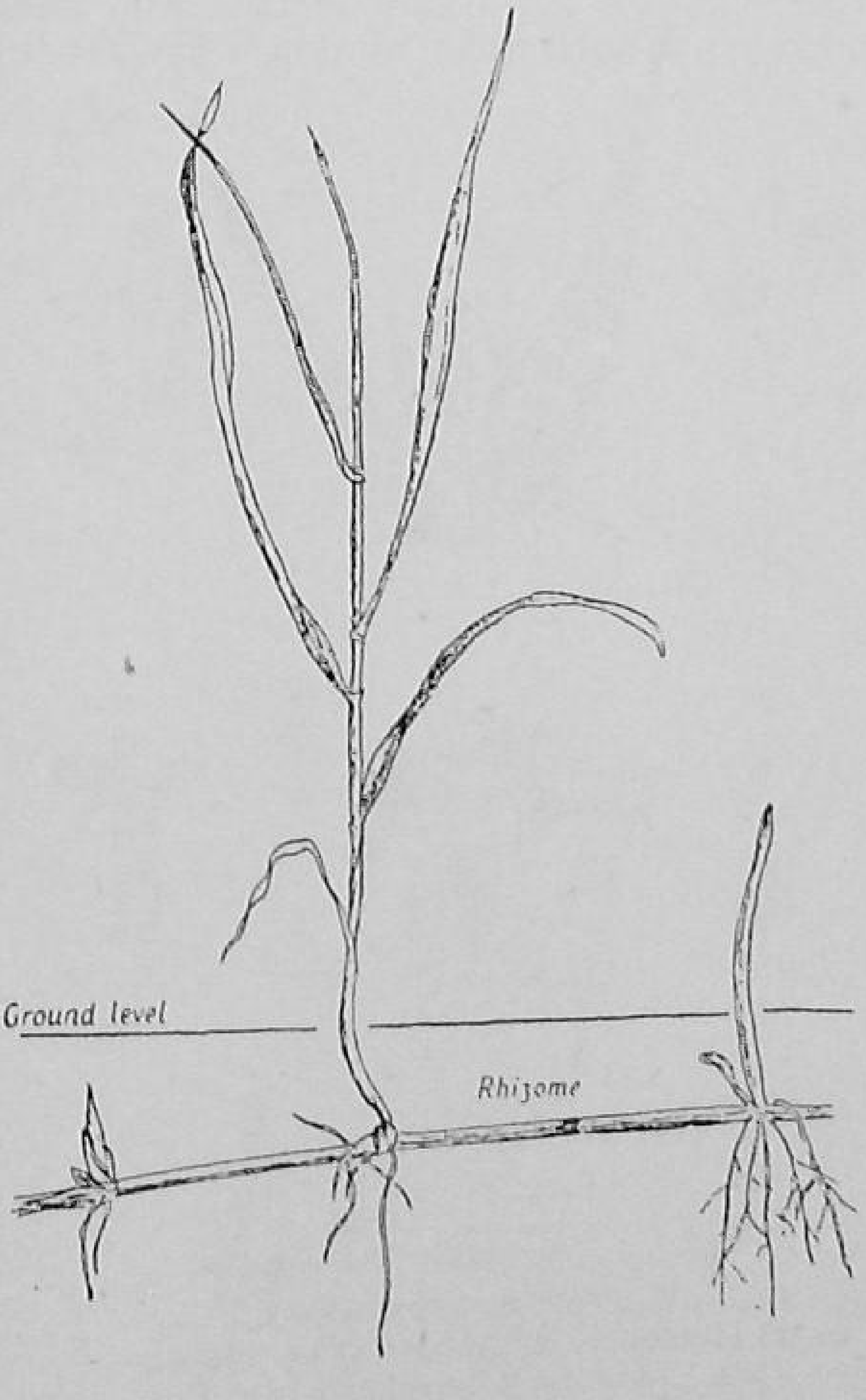

FIG. 5a. Rhizome of Couch Grass.

The Base of the Blade.

Much more valuable, however, from a recognition standpoint than the ligule is the appearance of the base of the blade at the point where it joins the sheath. In a few grasses, like the Rye-grasses and Couch-grass, the edges of the blades project as tiny claws, known to botanists as *auricles*. The largest claws are to be seen in barley, where they are enormous, and overlap each other; wheat has large claws, too, but some grasses like Perennial Rye-grass and Meadow Fescue have tiny claws. Obviously the thing to do here is to memorize those few grasses which have claws at the base of the blade, marking them as exceptions to the general rule that grasses, like the Meadow Grass under examination, do not have leaf claws, or auricles.

The stem of a grass is always a slender cylinder, whether it be immature and concealed within the enclosing leaf sheaths, or whether it be long, fully developed, and bearing an ear. A section cut across a stem always shows a circular outline. This is a point worth remembering, for even a shoot which is flattened in section encloses a cylindrical stem wrapped up in its folded leaves. It is the way in which the leaves are packed that decides whether the shoot is flat or cylindrical—not the stem, which is always a cylinder. Con-

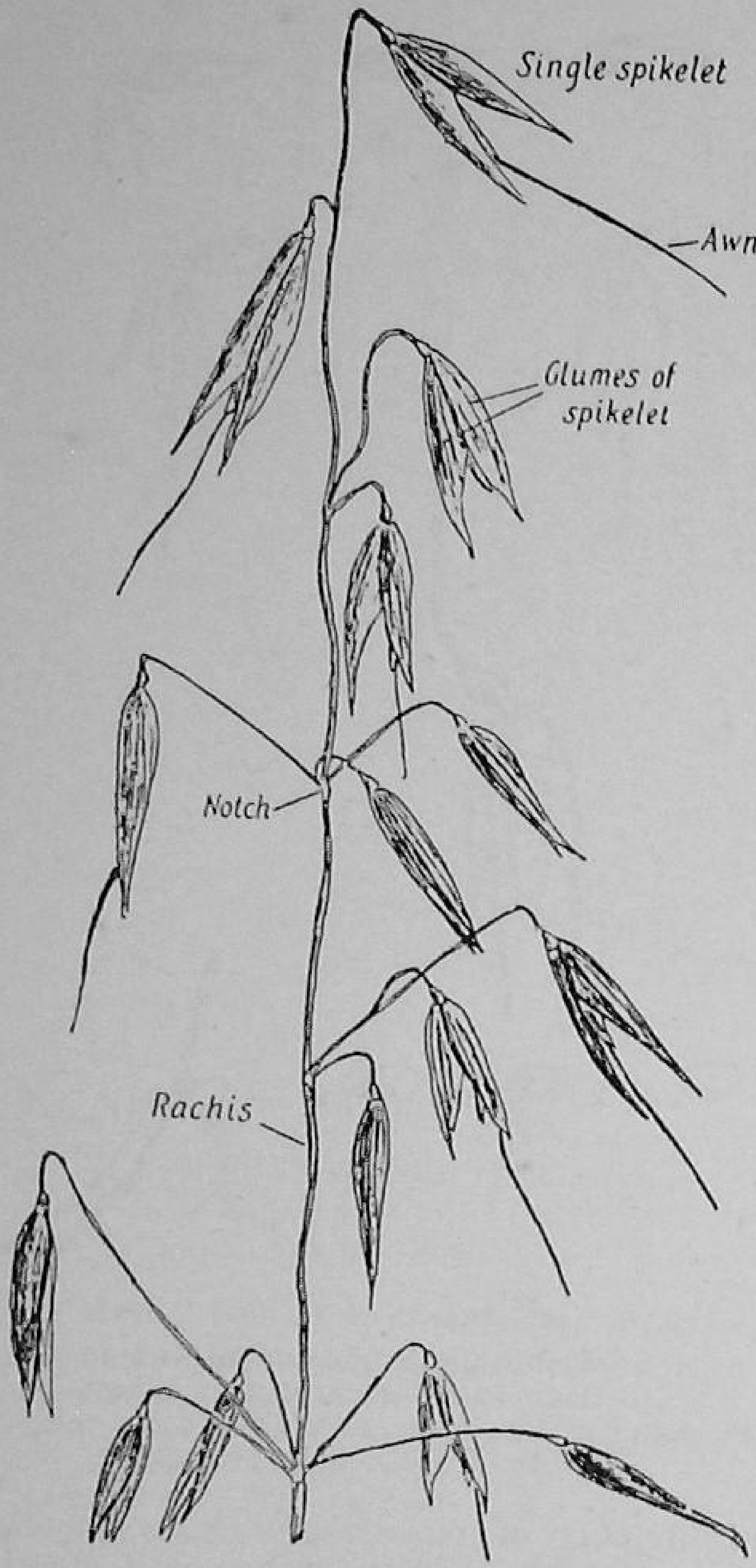

FIG. 6. Ear of Oat; a typical Panicle, each spikelet having its own stalk.

sequently, in trying to identify a grass from its leafy, or vegetative make-up, a young shoot should be chosen, because the development of a stout central stem tends to make a shoot with folded leaves appear more or less circular in section. This is where a hand lens is so useful, because it enables the enquirer to examine in detail the transversely cut surface of a doubtful shoot to decide if the leaves are folded or rolled.

The Stem.

The stem of a grass consists of a series of hollow cylinders interrupted by small, swollen joints called *nodes*, which are solid. The swelling at the node is caused by the storing up of material at the base of the leaf sheath, and is not due to an enlargement of the stem itself. The sheath of a leaf arises at one node, clasps the stem as far as the next upper node, and then, as the leaf blade, diverges from the stem.

The typical grass stem, or *culm*, is erect, and bears the ear. But in some grasses there is another sort of stem which has nothing to do with flowers and seed. It is a stem which runs more or less horizontally from the main plant. One kind of horizontal stem runs underground, the familiar example being that of couch grass, or squitch (Fig. 5a). Examination of a rhizome, or underground stem, of squitch reveals the presence of brownish, triangular scale leaves at each node of the stem, each concealing a large bud. It is these buds which give rise to the numerous

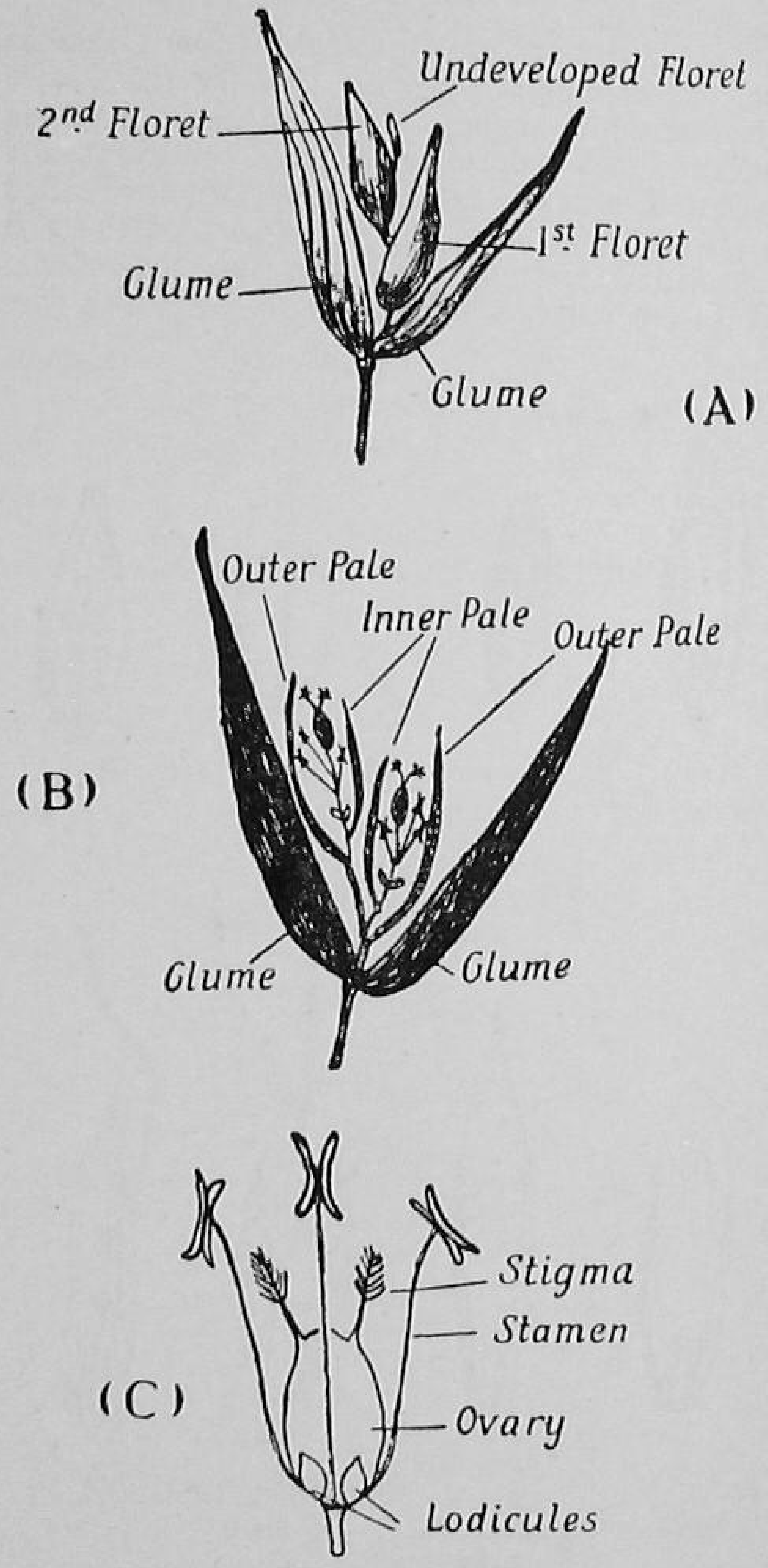

FIG. 7. Structure of a Spikelet.

A. Spikelet of Oat partially dissected.
B. Diagram of a Spikelet with two florets.
C. Diagram of the reproductive organs of a grass flower.

squitch plants and their roots, and make the species so dreaded by arable farmers.

Other species of grass, such as the Bent grasses, develop surface stems, or runners, which run on the top of the ground (Fig. 5b).

The Head or Ear.

The head, or ear, of a grass (technically called an *inflorescence*), is carried at the top of the stem. A description of the ear must of necessity contain a number of technical terms, because a student who wishes to make certain of identifying his grasses has to know precisely what is being described. These terms are not very hard to understand or remember, and they are well worth assimilating.

Taking the ear of Annual Meadow Grass as our first example, it is clear that the main stem gives off side branches from the nodes. The side branches may themselves branch, but eventually each stalk ends in a rather swollen structure called a *spikelet* (Fig. 6). The same sort of thing is found in the Common Oat, and since the spikelet of the oat is larger and easier to see, those who

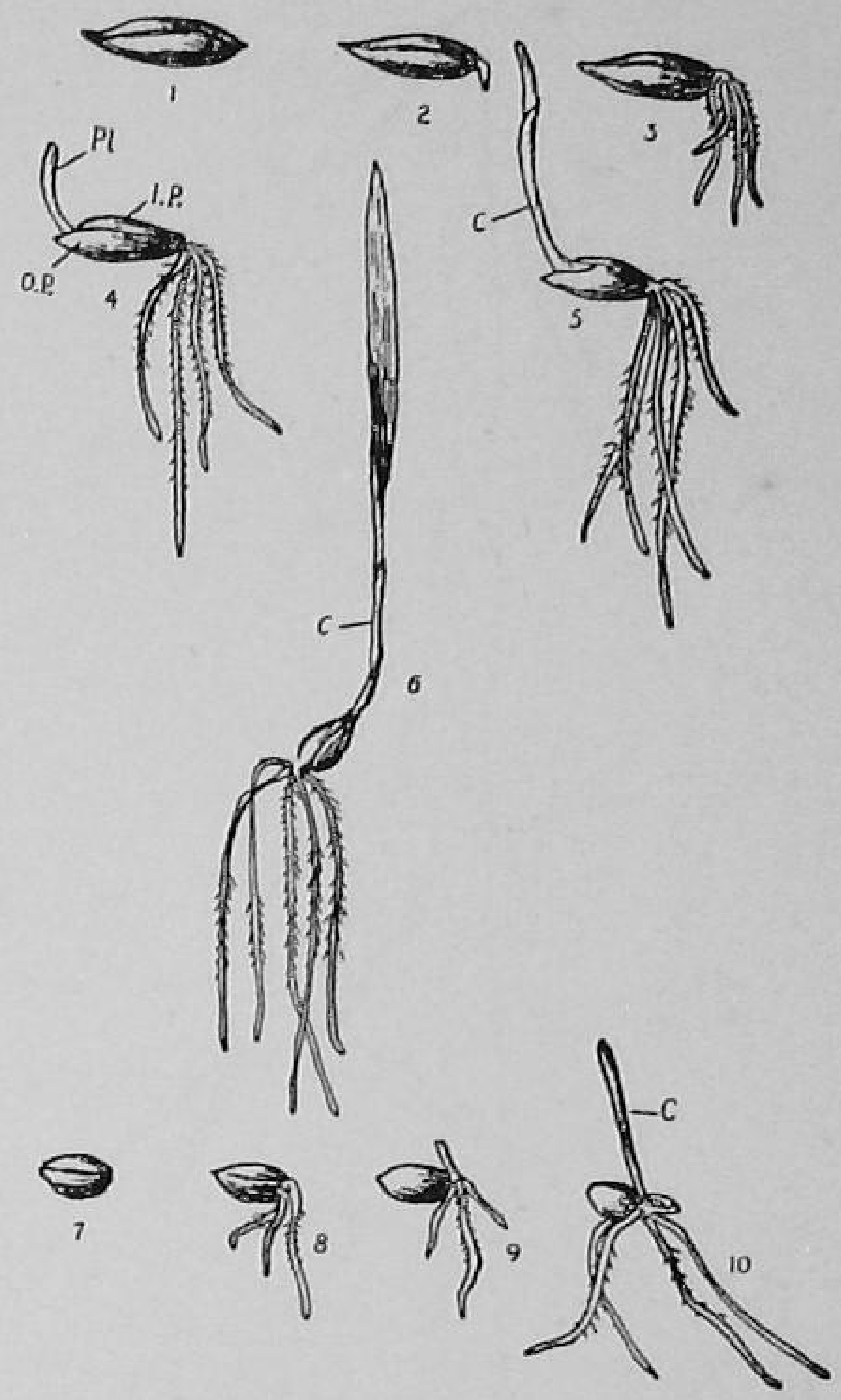

FIG. 9. Germination of a Grass "Seed."
1–6 Stages in the germination of Barley.
7–10 Stages in the germination of Wheat.
Pl, plumule; I.P., inner pale; O.P., outer pale; C, sheath or coleoptile of plumule.

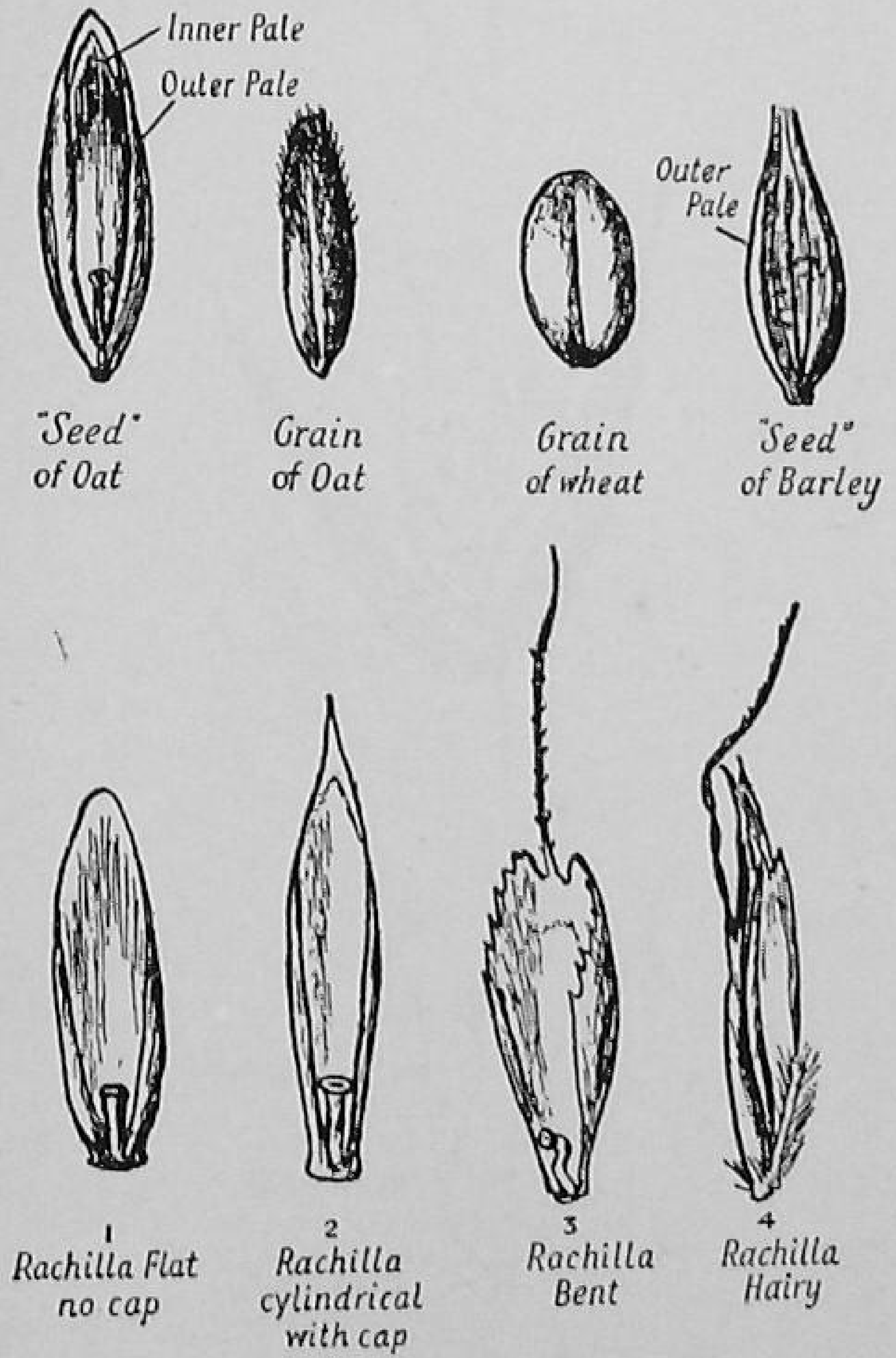

FIG. 8. (*Above*) " Seeds " and grains of Oats, Wheat and Barley. (*Below*) Types of Rachilla—
1. Perennial Rye-Grass. 2. Meadow Fescue.
3. Soft Brome grass. 4. Golden Oat grass.

begin the study of grasses when oats are shooting the ear may prefer to use this as their model. But whatever example is taken, the general structure of the spikelet is the same.

At the end of the stalk of the spikelet is to be found a pair of chaffy leaves called *glumes* (Fig. 7). In Meadow Grass they are much shorter than the spikelet, whereas in oats they are as long as, or longer than, the spikelet. The rest of the spikelet consists of a stalk on which is a number of individual flowers, each wrapped up in another pair of chaffy leaves called the *pales*. Usually the pale next to the central stalk is much smaller and thinner than the outer pale. As a matter of fact the outer pale is sometimes called the *flowering glume*. Very often the outer pale bears a bristle, called an *awn*; awns vary in shape, length and position in the different species, and consequently are of great value in the identification of grasses.

Within the pales are the reproductive organs of the plant. These consist of a more or less spherical *ovary*, bearing two feathery structures

called *stigmas*; three *stamens*, each made up of a stalk bearing the *anther*, or pollen-forming structure; and two very small structures called *lodicules*, which do not concern us greatly. When the stamens are fully developed they have long slender stalks, but before flowering takes place the anthers are relatively large, and appear as the most conspicuous feature of the undeveloped flower when the pales are prized apart.

It is the business of the anthers to produce the dust-like pollen, which falls on to the stigmas of the ovary, eventually fertilizing the egg within it to form seed. In most grasses the pollen is wind-borne from one grass to another, and cross-fertilization occurs.

The Spikelet.

To summarize this very brief account of the spikelet: the spikelet consists of two chaffy glumes enclosing a number of flowers situated on a central, jointed, stalk called the *rachilla*; each flower has its own reproductive organs enclosed within an outer and an inner pale.

When fertilization has taken place the ovary develops into the seed—strictly it is a "fruit," but we need not be so strict. The inner and outer pales become tougher, and wrap round the seed to protect it. The central stalk or rachilla breaks up into short lengths, with a portion adhering to the base of each seed and pressing against the inner pale (Fig. 8).

This combination of structures is what we see when we examine the commercial seed of grasses. Particular attention should be paid to the shape of the pales, to the presence or absence of bristles on the outer pale, and to the shape of the rachilla, for it is by such small points that grass seeds are identified. He who can recognize grass seeds can identify flowering grasses as they grow.

The commonest form of grass ear is that just described, where each spikelet has a distinct stalk attached to the main stem. Such an ear is called a *panicle*, no matter whether the ear be open and spreading like that of meadow grass, or very dense like that of timothy. But in a few grasses the spikelets arise direct on the main stalk, or axis, and have no individual stalks. Examples are the rye-grasses, wheat, and couch grass; such ears are called *spikes*. The number of grasses having spikes for their ears is small compared with those having panicles, consequently it is easy to remember these and to assume that all the rest have panicles.

"Inflorescence."

The term "inflorescence" is very commonly used by botanists to describe the ear of grasses. Actually it is no more precise than the word ear; for strictly the ear of a grass is a compound inflorescence consisting of a number of true inflorescences (i.e. the spikelets) collected together into a panicle or a spike. The term ear, or flower head, is good enough for general use.

It has already been said that the so-called seed of a grass is botanically speaking a fruit. Actually, it is even more complicated than this. By botanical definition a fruit is a fully developed ovary and in most grasses this fruit, which we call the grain or berry, is wrapped around by the inner and outer pales. It is lucky for us that this is the case, because the grains of grasses are all very similar, and we rely upon the appearance of the outer pale in particular to tell us the name of the seed. The seed of barley is typical of grass seeds: its "skin" is formed by the pales, which wrinkle characteristically on drying; the outer pale bears the long bristle, or awn, so typical of the species. Wheat, however, has a naked grain, for the berry itself threshes out from its pales.

The Berry, or Grain.

The berry, or grain of wheat, is a typical *caryopsis*—the term used to denote a special form of fruit containing one seed only. Most of the grain is a mere storehouse of starchy matter called endosperm, but down at the base of the grain, opposite the furrow, is a small raised structure, the germ or embryo. Growth takes place from this region when germination occurs.

GERMINATION.

The first things to appear during germination are the young rootlets. These are always fibrous, and there is no tap root (Fig. 9). Roots arise in rapid succession from the area of the embyro, and because they do not develop in any fixed order they are often said to be adventitious. Roots can, of course, develop from the nodes of prostrate stems in much the same way.

The shoot of a grass develops from the plumule, which is made up of a colourless, transparent, cylindrical sheath containing a green leaf. The sheath protects the leaf until it bursts through the ground; other leaves are then rapidly formed.

Grass seeds can germinate and develop into plants when buried at quite considerable depths. In soils which do not pan down to a hard surface crust, many farm grasses can be planted with every confidence as deep as 1–1½ inches below the surface. A covering of about one inch of soil is of great value to grasses sown in a soil which is liable to dry out badly in early summer, for it has a better chance of obtaining moisture at this depth compared with seeds lying more or less on the surface.

GRASSES OF AGRICULTURAL IMPORTANCE

We pass on here to consider grasses that are useful to the farmer for various purposes; and then some worthless grasses are mentioned. In both cases those characteristics are indicated which are useful to the farmer for recognition.

A VERY large number of different grasses is to be found in the British Isles—some authorities have listed as many as 130 species. Very few of these are of any importance to the farmer, and still fewer are actually sown by him when laying down land to short or long leys.

ESSENTIAL INFORMATION.

For the purpose of this book we are not proposing to describe all the grasses found in these islands, nor indeed even to list all the species occurring in grassland. The purpose of these first few sections is to impart the minimum essential of information to the would-be student of grassland; to give him, as it were, the skeleton of facts upon which to hang the flesh of his own observations. The classification and mode of dealing with the grasses about to be disclosed may give the systematic botanist some severe shocks, but the man in the field should find the information sufficiently accurate for his purpose.

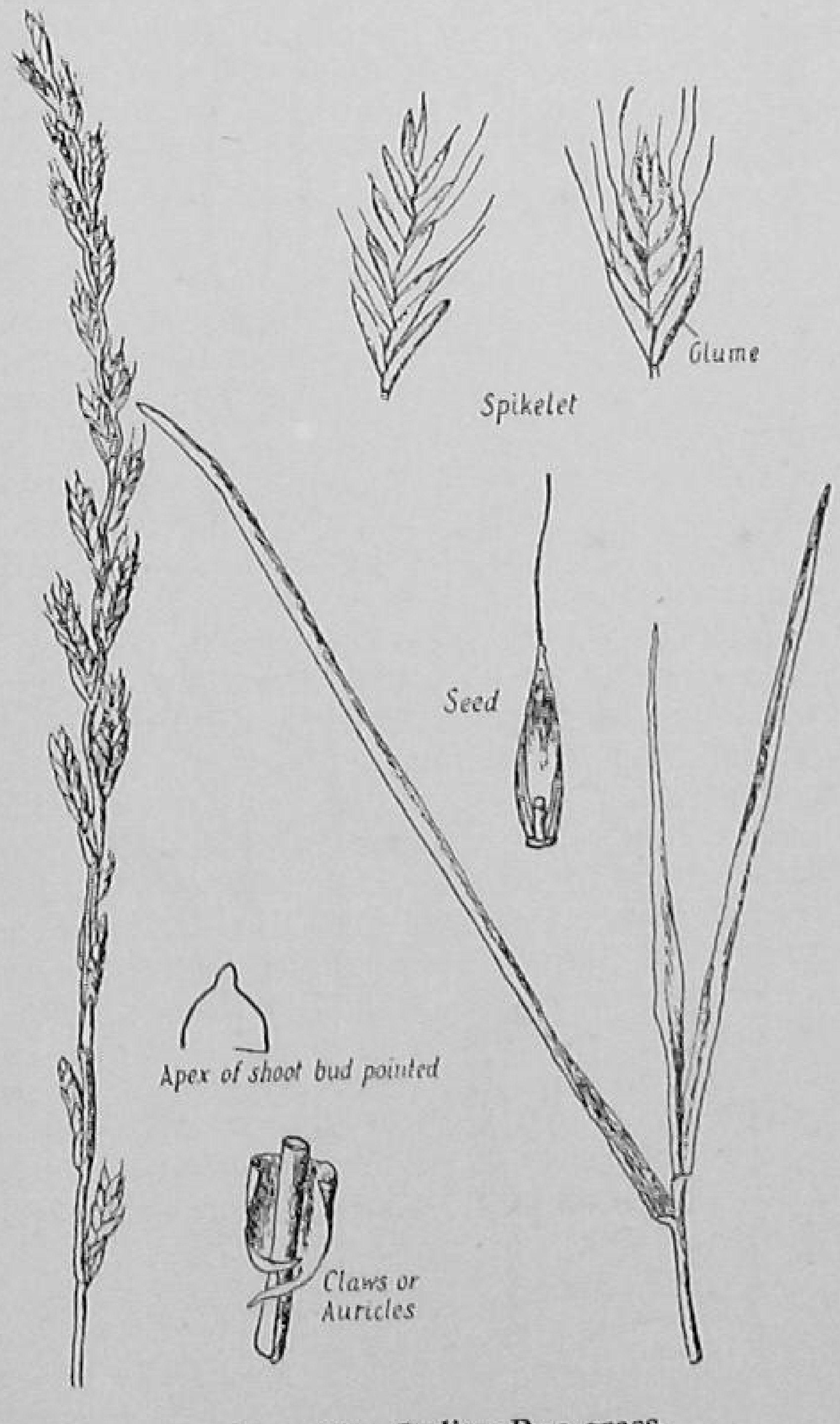

FIG. 10. Italian Rye-grass.

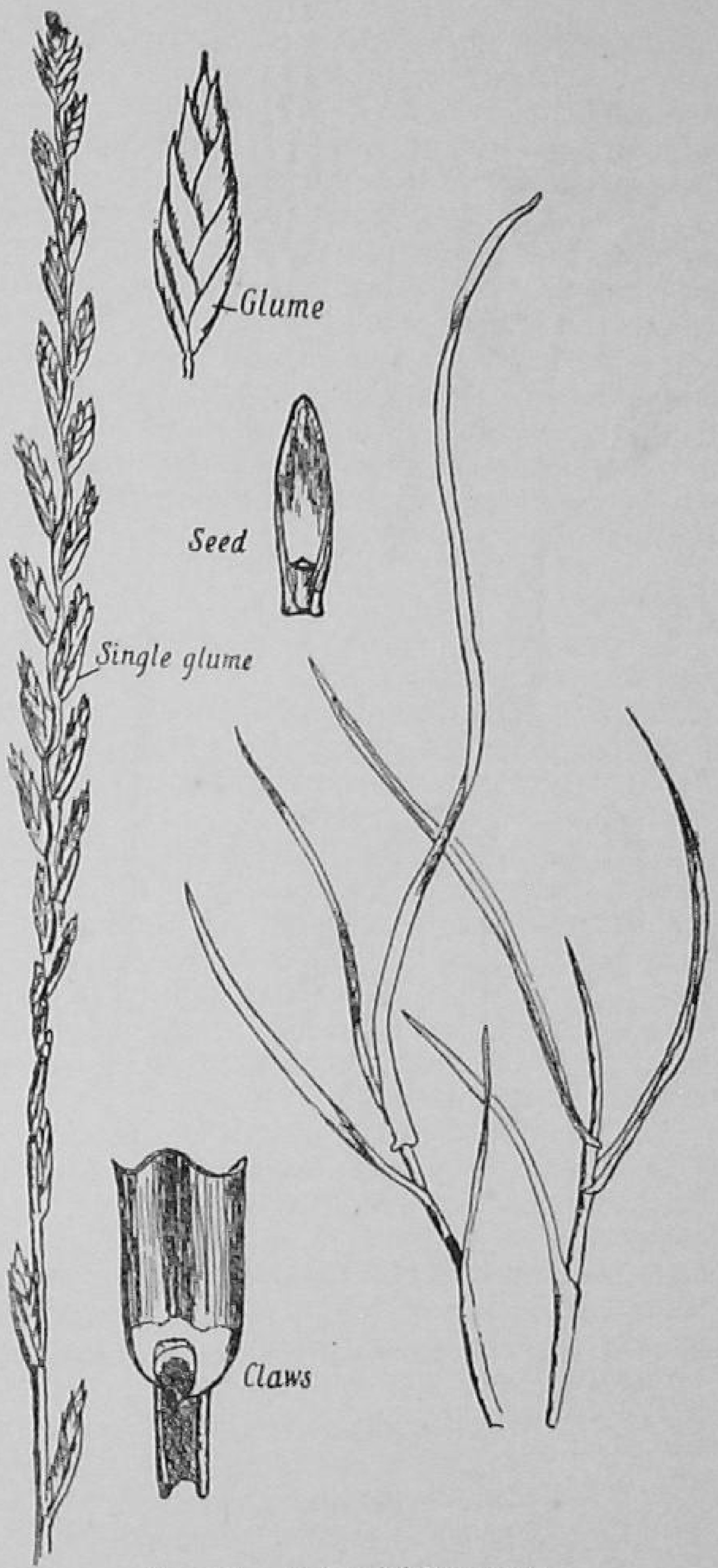

FIG. 11. Perennial Rye-grass.

GRASSES CLASSIFIED ACCORDING TO THEIR VALUE TO THE FARMER.

1. GRASSES WIDELY USED FOR SEEDING DOWN LEYS

   Rye-grasses (*Lolium* spp.)*
   Cocksfoot (*Dactylis*)
   Timothy (*Phleum*)

* spp. = short for species. *Lolium* spp. means "species of *Lolium*." *Lolium* is the genus to which the species known as Italian rye-grass and perennial rye-grass belong.

1. Grasses Widely Used For Seeding Down Leys.

Rye-Grasses—Genus *Lolium*.

These are the most widely cultivated grasses in the British Isles, and farming would be a difficult business indeed if they were no longer available. The chief distinguishing vegetative characters are the claws at the base of the leaves, the reddish-coloured basal leaf sheaths, the very glossy under side and the dull upper surface of the leaves, and the small ligule.

The ear consists of a central, wavy stem on which is situated, without any stalks, a number of spikelets arranged alternately. The spikelets have only one glume, the outer one, and contain up to ten florets which tend to fan out and form a very flat ear. The rachilla of the seed is flat and has no cap. There are two important species in the genus *Lolium*—Italian rye-grass and perennial rye-grass—which differ considerably in structure, habit and agricultural value.

Italian rye-grass (*Lolium multiflorum*, or *L. italicum*) (Fig. 10) has a cylindrical shoot, very distinct claws at the base of the leaf, and is very

Fig. 12. Cocksfoot.

2. Grasses less frequently used for seeding down leys

Meadow grasses (*Poa* spp.)
Meadow fescue (*Festuca*)
Meadow foxtail (*Alopecurus*)
Crested dogstail (*Cynosurus*)
Tall oat grass (*Arrhenatherum*)

3. Useful pasture grasses not commonly sown

Small fescues (*Festuca* spp.)
Sweet vernal grass (*Anthoxanthum*)
Golden oat grass (*Trisetum*)

4. Worthless grasses common in poor old grassland

Bent grasses (*Agrostis* spp.)
Mat grass (*Nardus*)
Tor grasses (*Brachypodium* spp.)
Yorkshire fog (*Holcus*)
Flying bent (*Molinia*)
Couch grass (*Agropyrum*)
Hair grasses (*Aira* spp.)
Meadow barley grass (*Hordeum*)
Brome grasses (*Bromus* spp.)

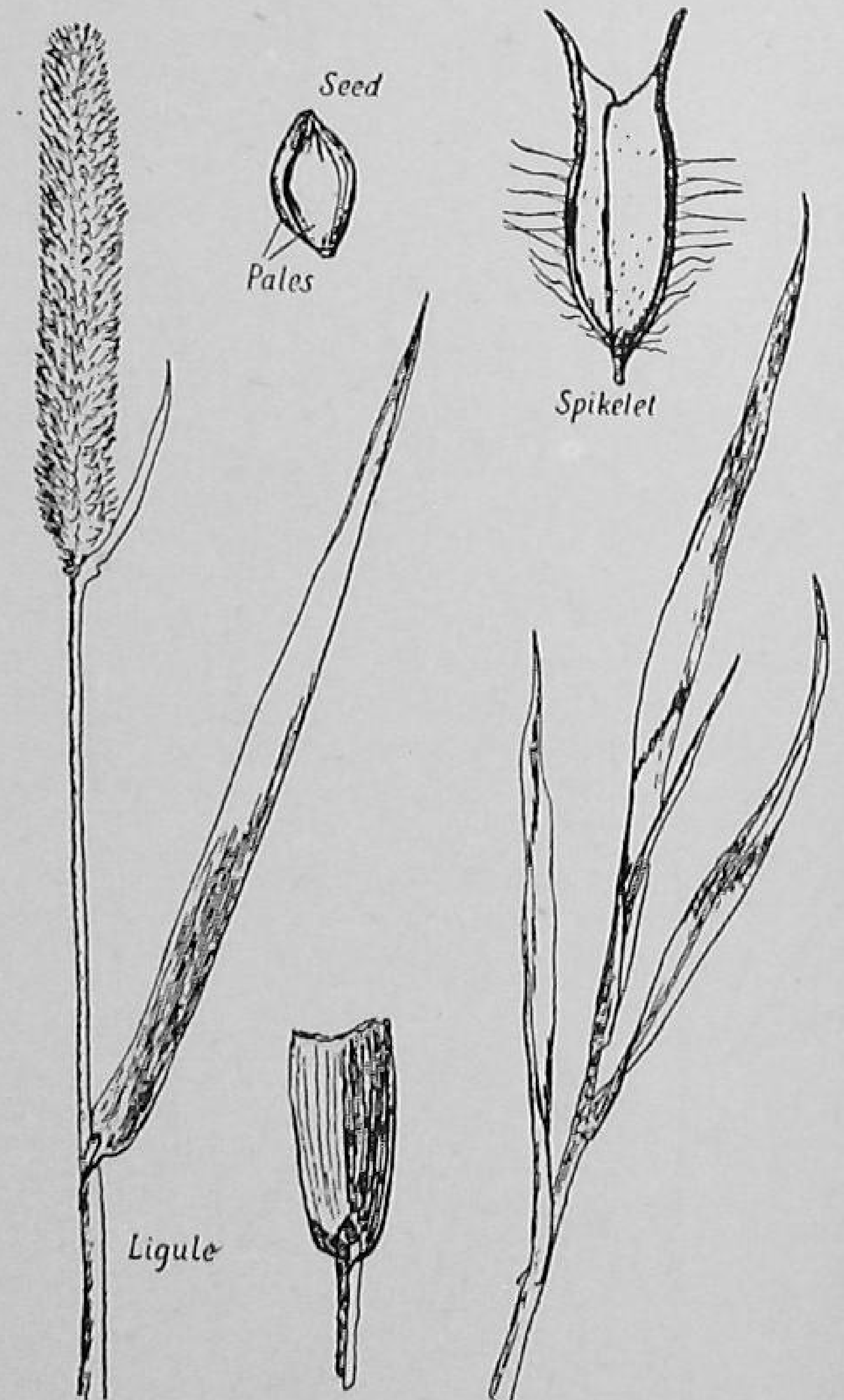

Fig. 13. Timothy.

tufted and erect in growth. When in ear it is easily recognized by the awn, or bristle, at the tip of the outer pale. The rachilla tends to be cylindrical, but has no cap.

Italian Rye-Grass.

Italian rye-grass behaves more or less as a biennial, and after yielding very heavily for one season it tends to die away rapidly. It is very palatable, and responds well to large doses of nitrogen. It does not tiller much, but forms large upright tufts. For leys of one year's duration it is of great value, because it both grazes well and yields much hay. It starts growing early in the year, and comes again strongly after a hay crop. There is evidence to show that it has a depressing effect on red clover if sown too abundantly, and although it has been widely recommended to be sown at the rate of 10-lb. per acre as a nurse crop for long leys seeded down without a cereal cover crop, it may, in fertile conditions, do harm by crowding out the less robust grasses during the first eighteen months. For stubble grazing in the autumn and winter of the year of sowing, Italian rye-grass has no equal; it is also very useful as a pioneer crop in the reclamation of poor and hill land. As a short duration grazing plant it is in a class by itself.

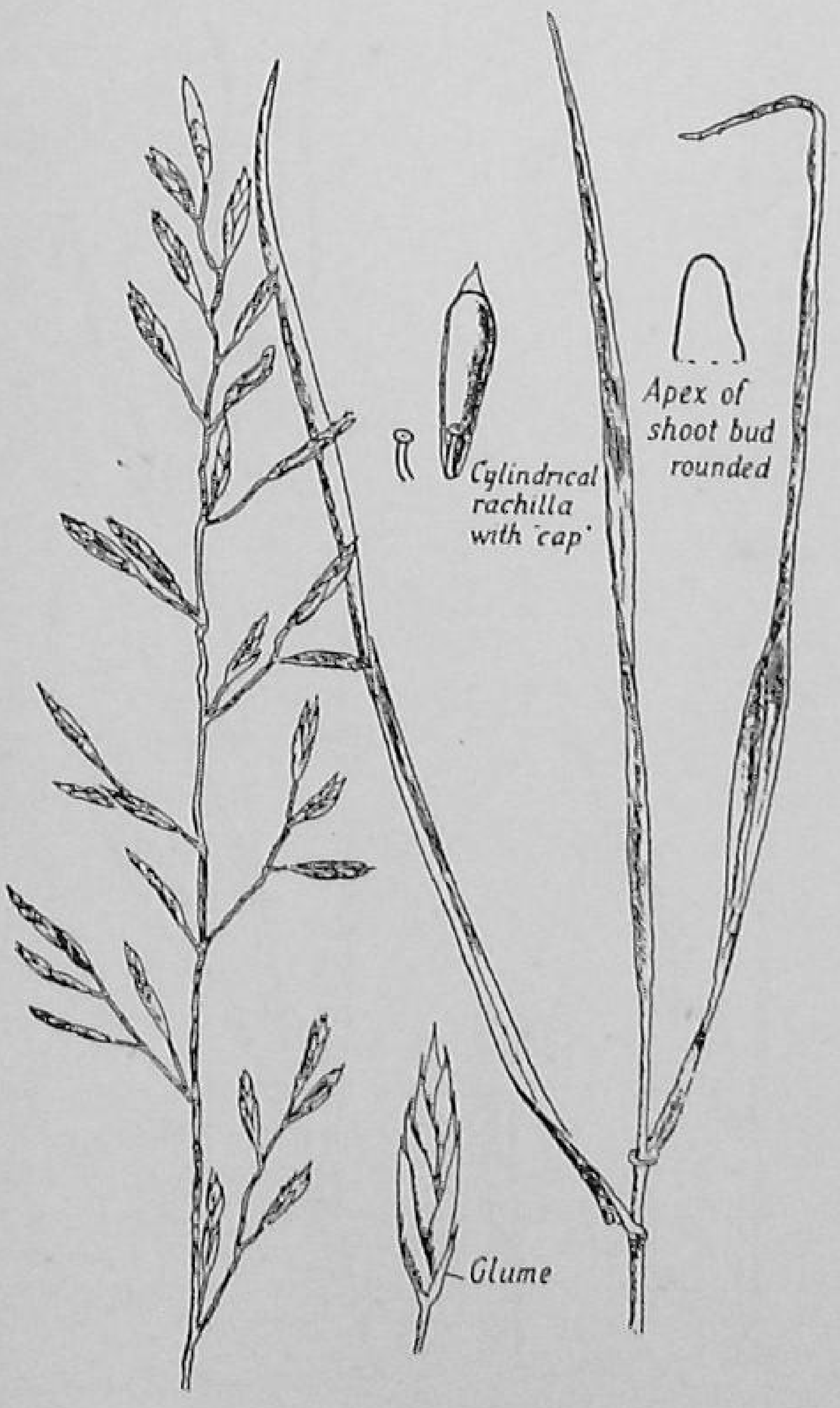

FIG. 14. Meadow Fescue.

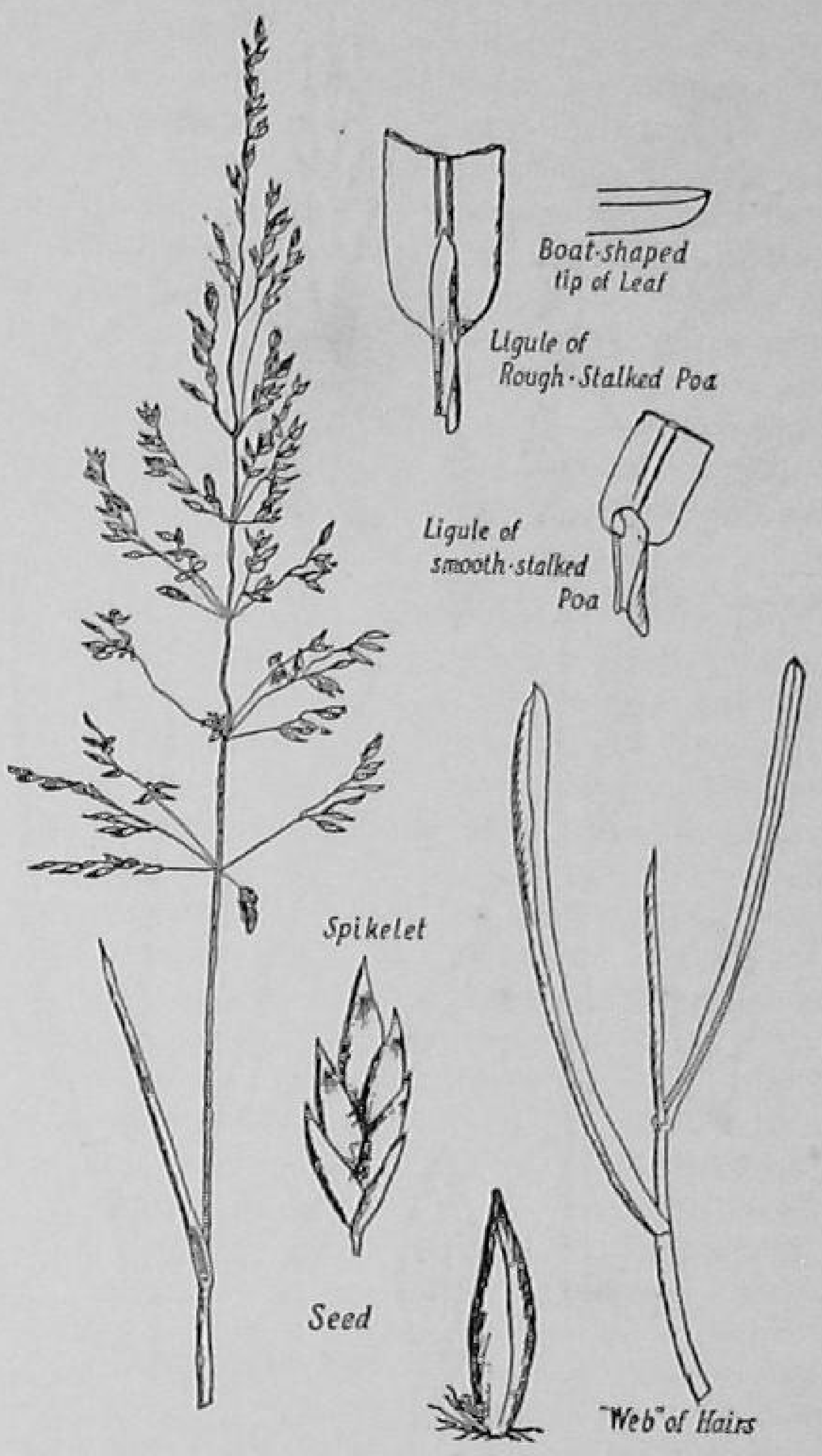

FIG. 15. Meadow Grasses or Poas; Smooth-stalked and Rough-stalked.

Perennial Rye-Grass.

Perennial rye-grass (*Lolium perenne*). This grass closely resembles the previous species, but can be distinguished from it by its more flattened shoot, its smaller leaf claws, its less tufted habit and generally narrower leaves, and by the absence of awns on the outer pales of the florets (Fig. 11). The rachilla of the seed is definitely flattened.

Perennial rye-grass is, without question, the most generally useful grass we have. On all soils except the very dry ones it grows well to give good pasture and good hay. It forms the basis of most of the seeds used for both one-year leys and leys of all duration up to permanent pasture. On dry soils, and in low rainfall areas, the species does not develop good roots, and rapidly becomes tufty, stemmy and unproductive; in such con-

ditions it should be replaced by cocksfoot. Most of our *good* old pastures contain a high proportion of perennial rye grass and wild white clover, and this, rightly or wrongly, has become accepted as one of the hall marks of good grassland. Perennial rye-grass grows quickly from seed, and when established is characterized by the way in which it continues to grow during the autumn and winter. Its weaknesses are its lack of production during the critical months of July and August, and its lack of the humus-producing capacity so marked in cocksfoot. For best results this grass needs fertile soil.

Many Different Strains.

It is difficult to regard perennial rye-grass as any one species, because it exists in very many different strains, all having generally similar vegetative and floral characters, but differing widely in habit. At the one extreme are short-lived, erect, stemmy early-flowering types, and at the other extreme are very persistent, prostrate, very leafy, late-flowering types. Many of the so-called commercial strains of perennial rye-grass are of the first type; some of them are more leafy, and rather longer lived. They may be looked upon as hay types. These strains start rapid growth in spring at an early date. Aberystwyth S. 24 is a superior strain of the commercial class which is more leafy than most, while retaining the early growth and free formation of seed so characteristic of the Irish and Scotch strains. New Zealand certified perennial rye grass behaves very much like S. 24.

At the other end of the scale come the super-leafy, late flowering, prostrate pasture strains typified by Aberystwyth S. 23 and S. 101, and Kentish indigenous. These flower three weeks later than the commercial types, and are also slower to start vigorous growth in spring. They stool out more freely and are more persistent in many parts of the country than the other strains of perennial rye-grass. These pedigree strains knit together rapidly into a turf capable of bearing the weight of cattle, without letting their feet through on to the soil beneath except in very wet weather. This is an important factor on heavy land. They produce much less seed than commercial strains, so the price per pound is higher. Kentish indigenous perennial rye-grass approximates to these two Welsh strains, but is less uniform in type. The Swedish Svalof Victoria is a late-flowering strain, but it behaves more like the commercial hay types.

Variations in Habit.

To appreciate properly the differences between the various strains of perennial rye-grass, cocksfoot and timothy, it is necessary to see them growing alongside one another, preferably in double rows. The variations in habit when exhibited are most striking and informative.

Cocksfoot.

Cocksfoot (*Dactylis glomerata*) is an extremely easy grass to recognize, both before and after the formation of the ear. The shoot is extremely flat and broad, with a strong keel, or mid-rib to the leaf sheath. The blade is ashy green; there are no claws, but the ligule is long and ragged, and very conspicuous. The plant is free from hairs.

The ear is quite unmistakable (Fig. 12) with clusters of spikelets on short branches. The ripe floret, which is the commercial seed, has a characteristic curved appearance. It is sharply keeled right along the back of the outer pale so that it always lies on its side, and the rachilla is cylindrical, with a distinct cap.

The root system of cocksfoot is deep and penetrating, so that the plant is able to stand up to much drier conditions than, for example, the rye-grasses. It succeeds on soils too poor to support satisfactory perennial rye-grass, but we are just beginning to realize that cocksfoot will also do very well on stiff clays and fertile soils usually considered the proper place for rye-grass and timothy. As a hay producer cocksfoot is very good, though early cutting is advised, because after flowering the stems become coarse and woody. The possibilities of cocksfoot as a pasture grass, especially in conjunction with white clover, are only now being properly investigated. For a long time many graziers have fought shy of cocksfoot, because when seed has been sown thinly the plants growing in isolated clumps tend to develop into hugh coarse tufts, which are difficult to control. If the seed is sown more generously, and if the pasture types are used, these disadvantages need not arise. Cocksfoot grows well under trees.

Two Types.

In old books on farming this grass is usually referred to as "rough" cocksfoot, but this roughness has now very largely been bred out. Two types of cocksfoot are now available, the hay type and the pasture type. Hay types are tall, rather coarse, and earlier to flower. They produce a large number of stems with leaves mostly on these stems; they are erect and do not tiller a great deal. The usual "commercial" strains are mostly of the hay type. Danish, French and Swedish strains are very typical. The Akaroa cocksfoot comes from a district of that name in New Zealand; it is intermediate between the hay and pasture types. Aberystwyth S. 37 is a hay type which also grazes very well. S. 26 is called a hay-pasture type, while S. 143 ("Mop" strain) is a super-pasture type. It is much denser, produces more leaves from the base and fewer and shorter stems than the hay types. It is more spreading because of its numerous tillers. It is longer lived than the hay types.

Cocksfoot does particularly well when drilled

in rows, and it certainly does best when sown without a nurse crop.

Timothy.

Timothy (*Phleum pratense*). This is another grass which can usually be recognized fairly easily (Fig. 13). The shoot is cylindrical, and the base of the shoot is usually swollen like a bulb; if the outer brown sheathing leaves are pulled away from the base, a violet coloration can often be seen. In the very prostrate forms, such as S. 50, the swollen base may not be present. There are no claws to the leaf, but the ligule is conspicuous. The blades are light green, with flat ridges on the upper surface. The entire shoot is without hairs.

The ear is carried on a stem 1½–2 feet long, and is itself very variable in length. It may be only an inch long, but some inflorescences reach a length of 4–6 inches. The ear is almost, but not quite, a spike (see p. 286), for the spikelets are borne on extremely short stalks, so that the whole structure is a tight cylinder, from which the alternative name Catstail is derived. The glumes of each spikelet are sharply keeled, and the keel continues as a fine sharp point; the keel carries a number of long hairs. The grain, or caryopsis, of timothy is egg-shaped and tightly enclosed within the membranous, silvery pales, and looks more like a clover seed than a typical grass seed.

Timothy is frequently confused with meadow foxtail (see p. 295), but reference to the spikelet of the two species shows that the resemblance is very superficial.

Timothy is tufted in habit (except the S. 50

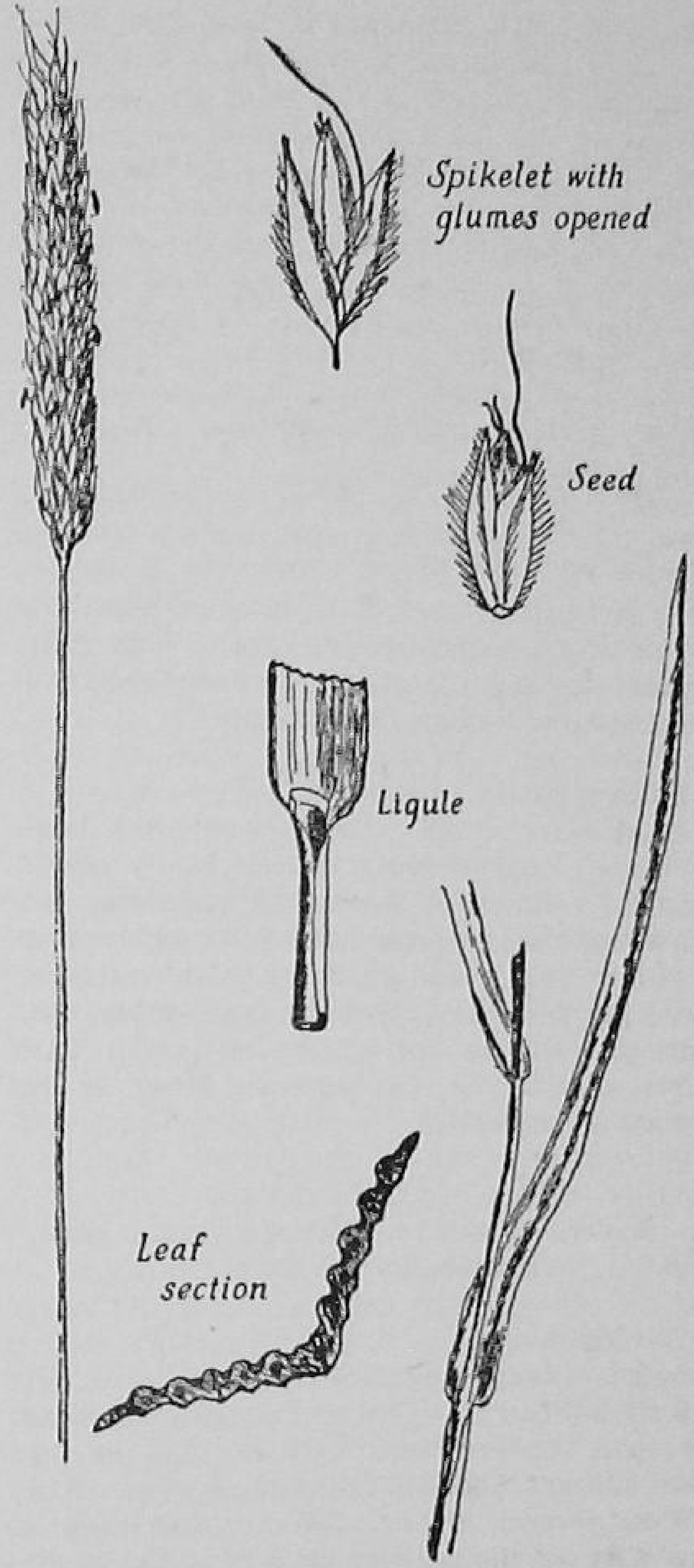

FIG. 17. Meadow Foxtail.

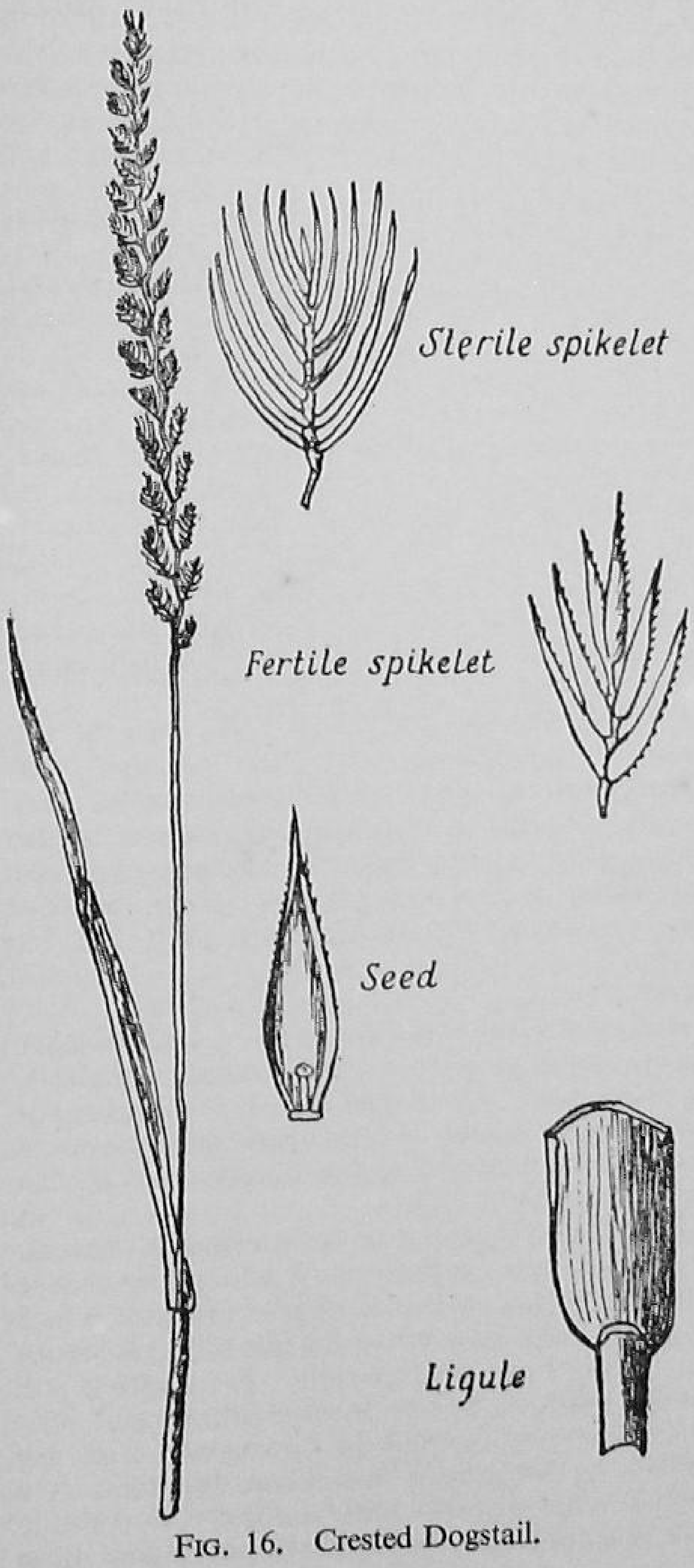

FIG. 16. Crested Dogstail.

strain), and much shallower rooting than cocksfoot. It is, therefore, a grass for the moister, stronger lands, and is of less value on light, dry soils. It is the most palatable of all grasses, but it is not always so persistent as one could wish even where conditions would seem ideal. Timothy flowers very late, during July, but this does not mean that it is necessarily very backward in producing herbage in spring; it is certainly behind rye-grass and cocksfoot, but not very far behind. A ley consisting very largely of timothy, however, gives a comparatively late cut of hay and little aftermath.

Timothy exists in both hay strains and pasture strains, the former being more stemmy and less persistent than the latter. Aberystwyth strains include S. 51 (hay type), S. 48 (pasture type) and S. 50 (a dense, super-pasture type). Generally, the American types are stemmy compared with those grown in Scotland and Sweden.

One Million Seeds.

The modern tendency is to sow very large numbers of timothy seeds per acre. A pound of timothy contains about one million seeds, and the usual sowing rate is from 4–8 lb. per acre; at the higher rate about twice as many seeds of timothy are sown as of perennial rye-grass, but, of course, with its much smaller seed, timothy is unlikely to establish as many seedlings as the larger seeded rye-grass.

2. Grasses Less Frequently Used for Seeding Down Leys.

Meadow Fescue.

Meadow Fescue (*Festuca pratensis*). In a well grazed pasture it is by no means easy to distinguish between this plant and Italian rye-grass. There is the same cylindrical shoot, with the lower sheath pink in colour; claws may or may not be recognizable at the base of the blade. The blade is glossy below, dull and ribbed above. These are characters shared with Italian rye-grass, and to distinguish between the two species it is necessary to pull back carefully the lower leaf sheaths of the plant and to examine the buds arising on the base of the stem. In meadow fescue the bud is comparatively broad and blunt, without any hairs (Fig. 14). In Italian rye-grass the bud is more slender, with a sharper point and may bear some fine hairs (examine with a lens) (Fig. 10).

The ear is a spreading panicle at the end of a culm 1½–2 feet long. Each spikelet has relatively tiny glumes, and 5–10 flowers. The ripe floret or seed, is very like that of Italian rye-grass with its awn broken off, but it can be distinguished because the rachilla is definitely cylindrical and capped, and stands well away from the inner pale. This is a valuable characteristic shared by all the fescues.

A Very Useful Grass.

Meadow fescue has not been very popular in the past, possibly because it does not establish itself well in competition with cocksfoot and rye-grass. Once established, however, it is a very useful grass, and recent work tends to show that for the production of hay over a period of years it may outyield perennial rye-grass. Rather half-hearted attempts have been made of recent years to breed improved types of meadow fescue, and we badly need more experimental work to determine how best to use this valuable plant.

A taller, coarser plant, with the same general description, common in hedges and waste places, is tall fescue; it has no value in farming, and can be recognized by its large claws, which carry short bristles, or hairs, along their edges, and by the very pronounced ribs on the upper surface of the leaf blade.

MEADOW GRASSES.

The meadow Grasses or Poas. The general appearance of a typical *Poa* has already been described (see p. 218). The commonly shared characters of the genus are: the distinctly flattened shoot; the peculiar boat-shaped tip of the leaf; the absence of claws, ribs and hairs on the leaves; the more or less spreading ear with its numerous ovate spikelets on long slender stalks, and the presence of a " web " of fine, short, silky hairs at the base of the outer pale of each floret (Fig. 15). This last is a very useful identification feature in the Poas when in flower, for the hairs can be clearly seen with the naked eye if the florets of a single spikelet are torn apart slowly between the fingers.

From a farming standpoint only two of the numerous species of *Poa* are of any real importance, though annual meadow grass may sometimes make a valuable contribution to the grazing of a field by filling in bare spaces. The two useful species are rough-stalked meadow grass and smooth-stalked meadow grass.

Rough Poa.

Rough-stalked meadow grass (*Poa trivialis*). This creeps slightly by surface runners, especially on moist soils. The stalk just below the ear is rough. The ligule of the uppermost leaves is long and pointed, but is less conspicuous on the lower leaves (Fig. 15).

Rough Poa is rather under a cloud at present, for it has been energetically accused by some research workers of taking up space on land which would be better occupied by timothy, cocksfoot or rye-grass. Unfortunately, the cutting off during war-time of the normal supplies of seed has made it impossible to experiment with the species as one would have liked, but there is a feeling amongst other pasture experts that rough Poa can form a useful addition to the flora

of the longer leys. It has the habit of covering the ground and filling in the spaces between more tufted grasses, thus assisting to check weeds. This habit may be useful under conditions of low fertility, whereas on more fertile soils it may be undesirable to introduce the species in competition with rye-grass or timothy. It is decidedly a grass for moist conditions, and in dry situations very quickly dies out. It is very palatable, though its productivity is low compared with perennial rye-grass.

Smooth Poa.

Smooth-stalked meadow grass (*Poa pratensis*), is a smaller, less productive grass than the previous one. It forms whitish underground stems, or rhizomes, some of which may be so long as to invite confusion with those of couch grass or squitch. Apart from its rhizomes, smooth Poa can be recognized by the leaf blades, especially the lower ones; these have almost parallel margins, ending abruptly in a blunt tip (Fig. 15). The ligule is short and blunt. Usually the so-called " white lines " can be easily seen in the leaves of this species by holding the blade to the light. A " white line " runs longitudinally on either side of the mid-rib. It flowers distinctly earlier than the rough-stalked species.

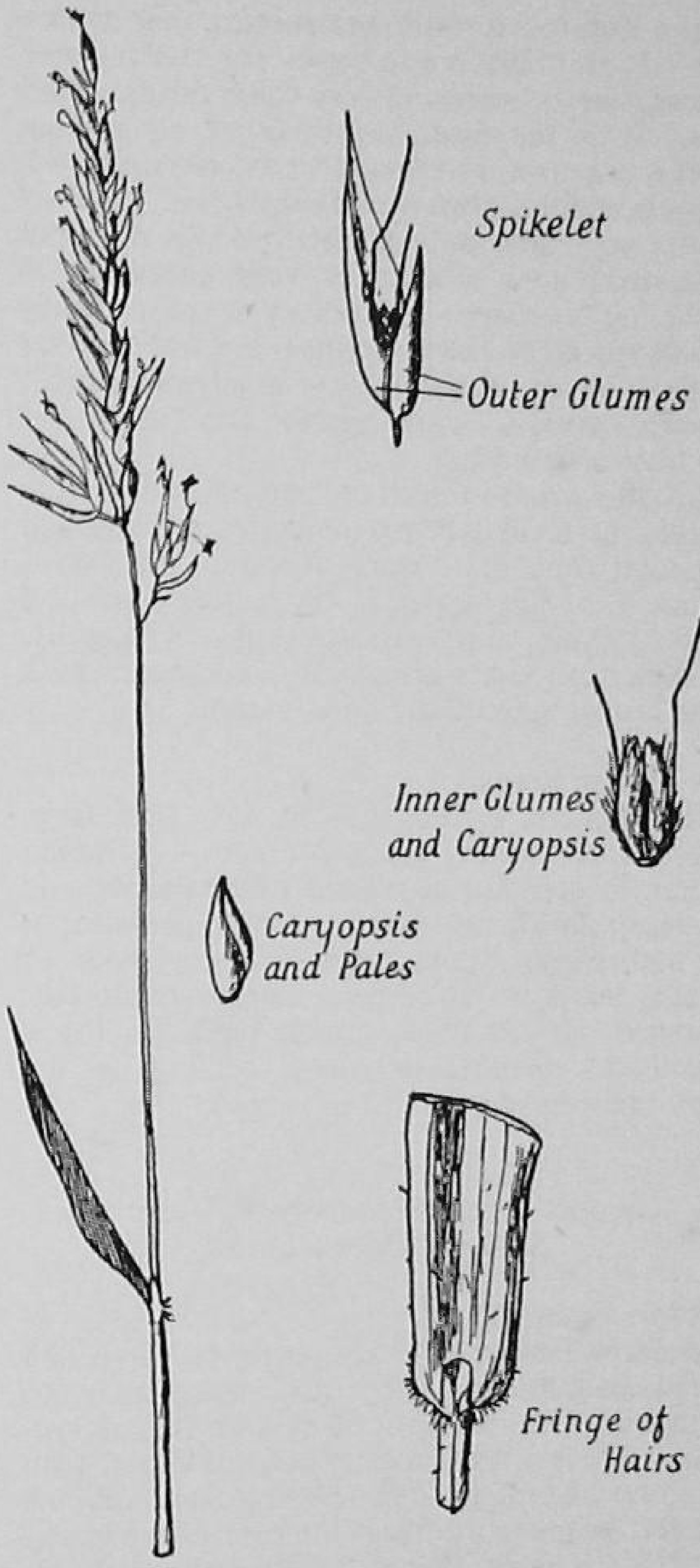

FIG. 19. Sweet Vernal Grass.

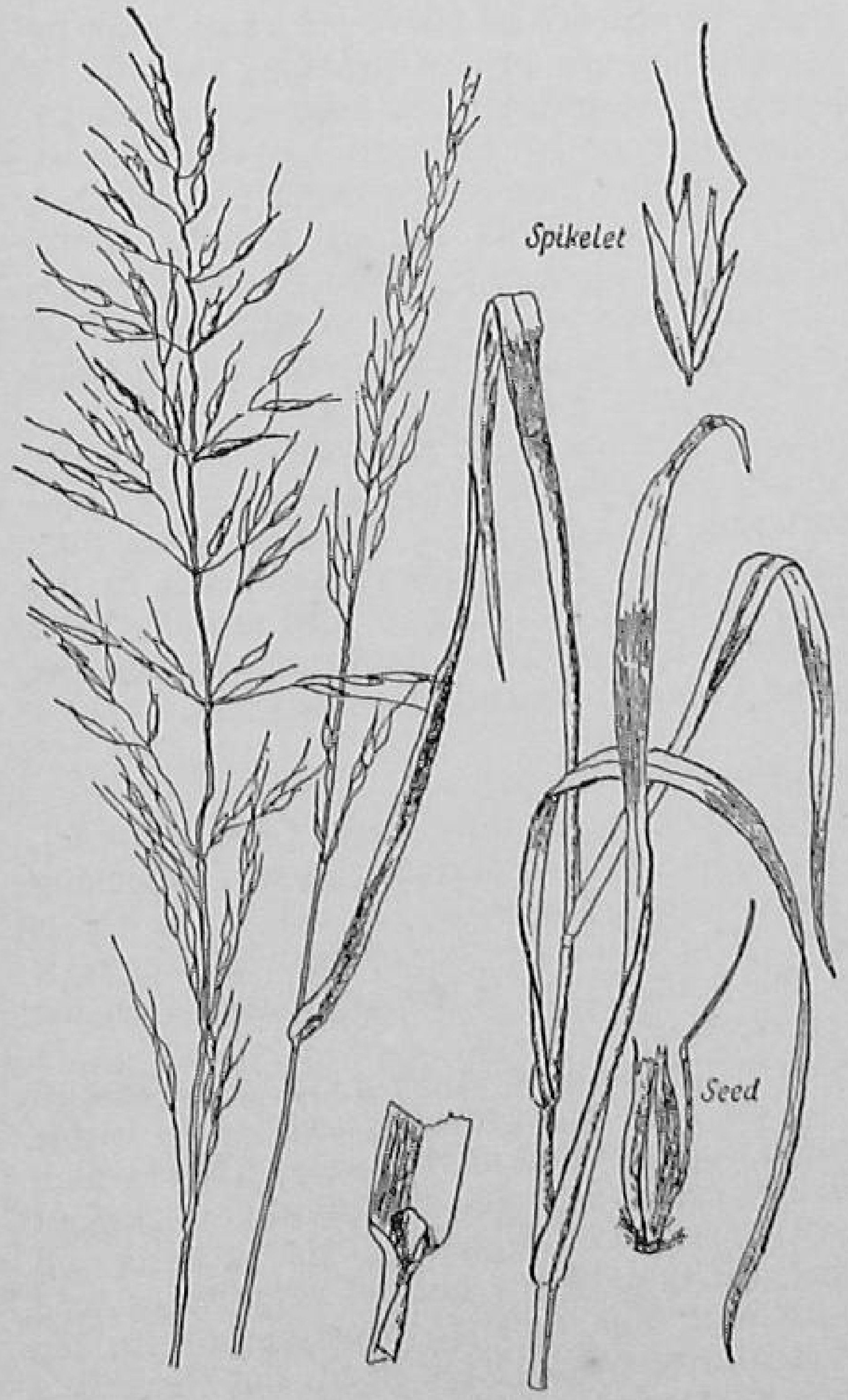

FIG. 18. Tall Oat Grass.

Except on dry soils smooth Poa has little farming value—it is more useful for lawns, poultry pens, and so forth. The war-time practice of substituting smooth Poa for rough Poa in seeds mixtures is a matter for regret; the two grasses behave quite differently and have quite different values.

Crested dogstail (*Cynosurus cristatus*). This widely-spread species is recognizable before flowering by the yellow colour of the lower leaf sheaths, and by the way the short, pointed leaf blades curve upwards to form a trough (Fig. 16). The shoot may be either slightly flattened, or distinctly cylindrical. There are no claws, no hairs, and very little ligule.

The ear is a very characteristic dense panicle, carried on a very tough stalk, or "bent," about a foot long. The ear is from 1–3 inches in length, with numerous spikelets on short branches all drawn to one side. The spikelets are in clusters, the outermost spikelets being sterile, i.e., are composed of glumes and pales without any of the essential organs of the flower and cannot form seed. The inner spikelets form seed, each consisting of the grain enclosed in the strikingly yellow pales; the rachilla is cylindrical with a conspicuous cap.

Dogstail.

Dogstail is a small tufted plant which remains remarkably green during the winter. It is essentially a grazing plant, whose value for food is offset to some extent by the typically wiry culms, or bents, which get into the eyes of grazing animals, to their annoyance. The species does well in most diverse conditions, on dry soils and on rich soils, and its palatability is good. Of course, its production is low, and it is best used on the less fertile soils, especially chalky ones. Its benty nature, which leads to the production and dissemination of much seed, may cause it to increase beyond a desirable maximum, and for that reason it should be used with caution on the better soils.

FIG. 21. Bent Grass or Agrostis.

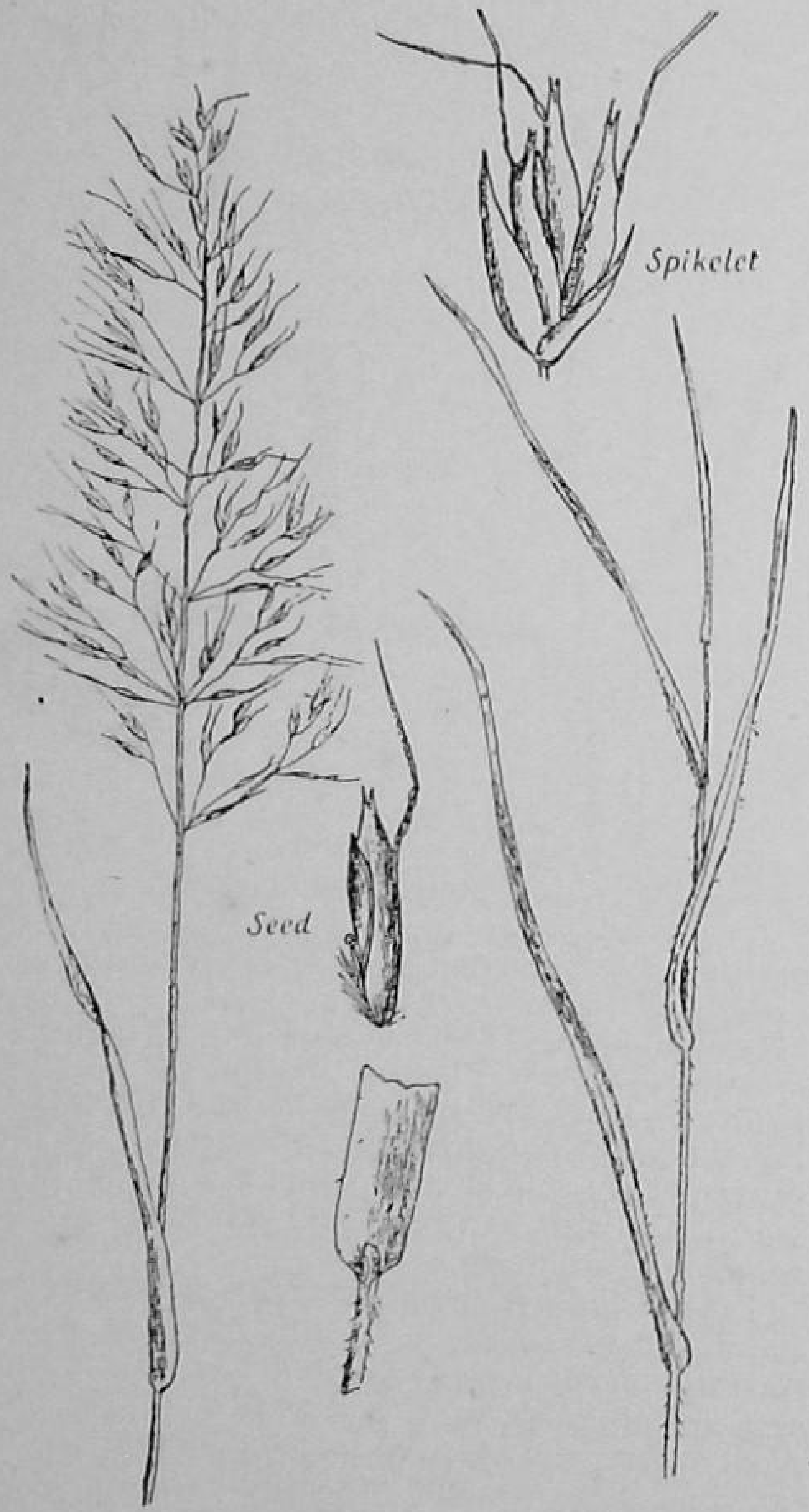

FIG. 20. Yellow or Golden Oat Grass.

Foxtail.

Meadow foxtail (*Alopecurus pratensis*). This is a species which cannot always be recognized easily in a grazing turf where the plants are small. The shoot is cylindrical, and the lowest sheaths are dark brown in colour. The blades are dark green, broad, distinctly ribbed on the upper surface, but without a very definite keel. There are no auricles and no hairs; the ligule is short and square.

The ear which is produced very early, in April, bulges out the top-most sheath in a very typical fashion just before appearing. It is a very dense panicle (Fig. 17), superficially similar to that of timothy, but with a totally different spikelet. The two similar glumes are boat-shaped and

hairy, and the outer pale has an awn fixed to its base; the awn is bent and gives an untidy, loose appearance to the ear which contrasts with the firm neatness of timothy. The culm is 1–3 feet long, and the ear 1–3 inches long.

Foxtail is very widely spread throughout our grasslands, and is a useful plant in permanent turf because of its earliness, productivity and palatability. It prefers moist, strong, rich land, yielding in such conditions good hay and good pasturage. Whilst meadow foxtail is undoubtedly a valuable species, it can as yet scarcely be seriously considered as a constituent of a seeds mixture. It establishes itself very unreliably from seed, and commercial samples are often of poor quality. Attempts to breed improved types of foxtail are still in the experimental stage.

Tall Oat Grass.

Tall oat grass (*Arrhenatherum avenaceum*). This is a coarse, tufted grass, readily identified by its bright yellow roots, and the tendency of several of the nodes at the base of the stem to become bulbous. The upper surface of the leaves is usually slightly hairy; there are no claws.

The ear is carried at the end of a culm from 2–4 feet long, and is an untidy panicle, which becomes spreading as it matures (Fig. 18). The spikelet is rather like that of the oat, with large enveloping glumes. There are two flowers in the spikelet, but the lower one does not form seed. On the outer pale of this infertile floret is a dorsal arm which is twisted and bent, and provides a ready means of identification.

Tall oat grass is found naturally in hedgerows on dry light land. It is little used in seeds mixtures, partly because the seed is very large and consequently expensive, and partly because the plant does not thrive in competition with perennial rye-grass and cocksfoot, and is soon grazed out of a ley. To obtain a good take of tall oat grass the rate of seeding must be heavy—at least eight to ten pounds per acre. The

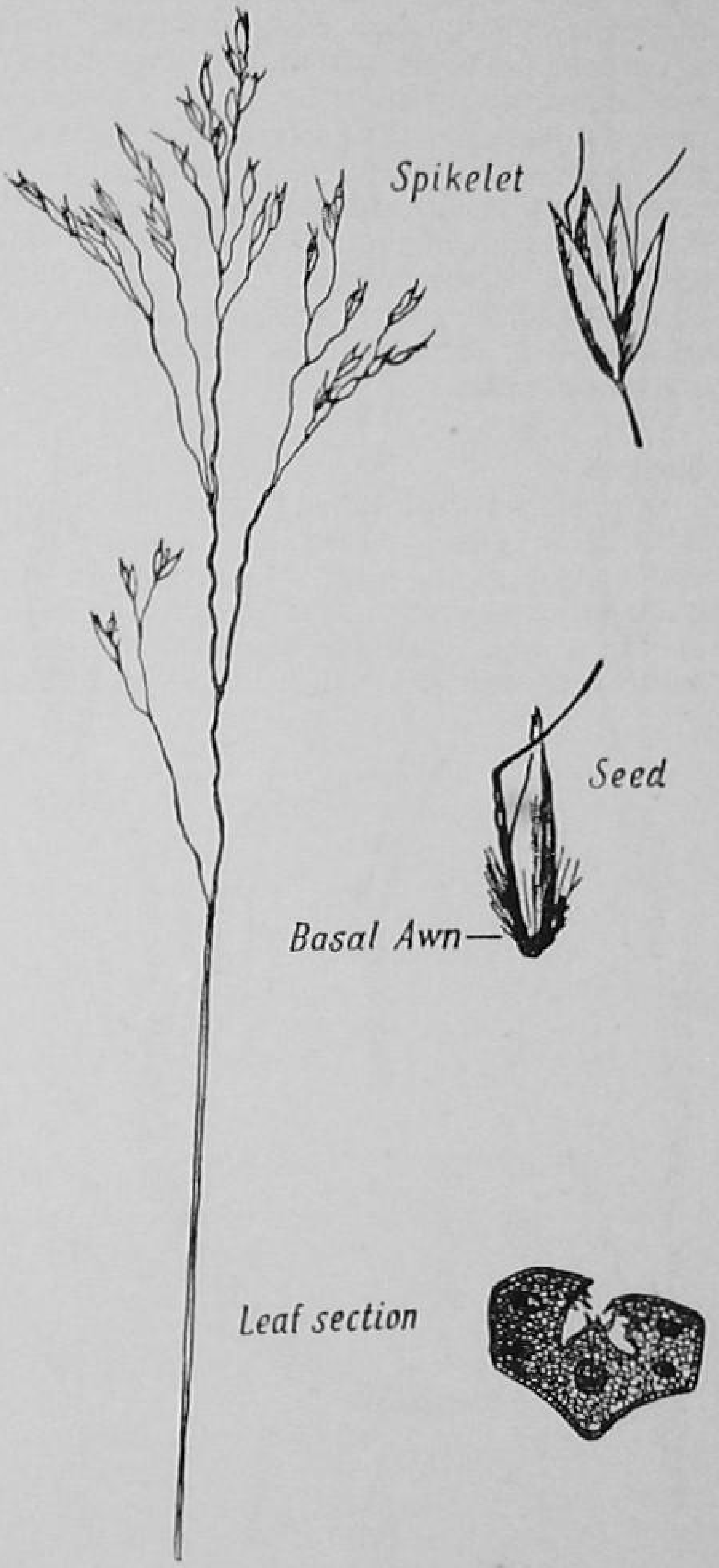

FIG. 23. Wavy Hair Grass.

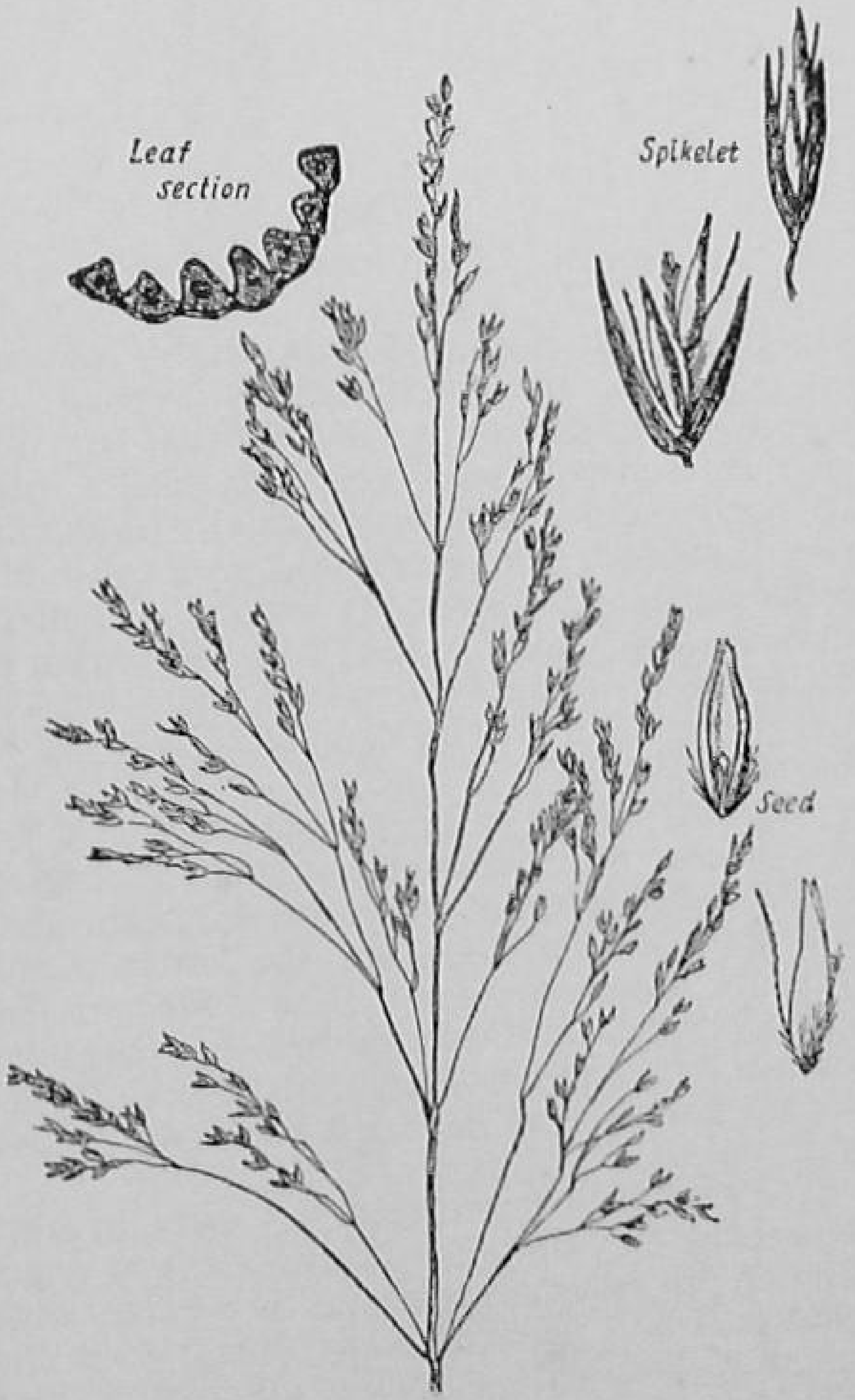

FIG. 22. Tufted Hair Grass or Tussock Grass.

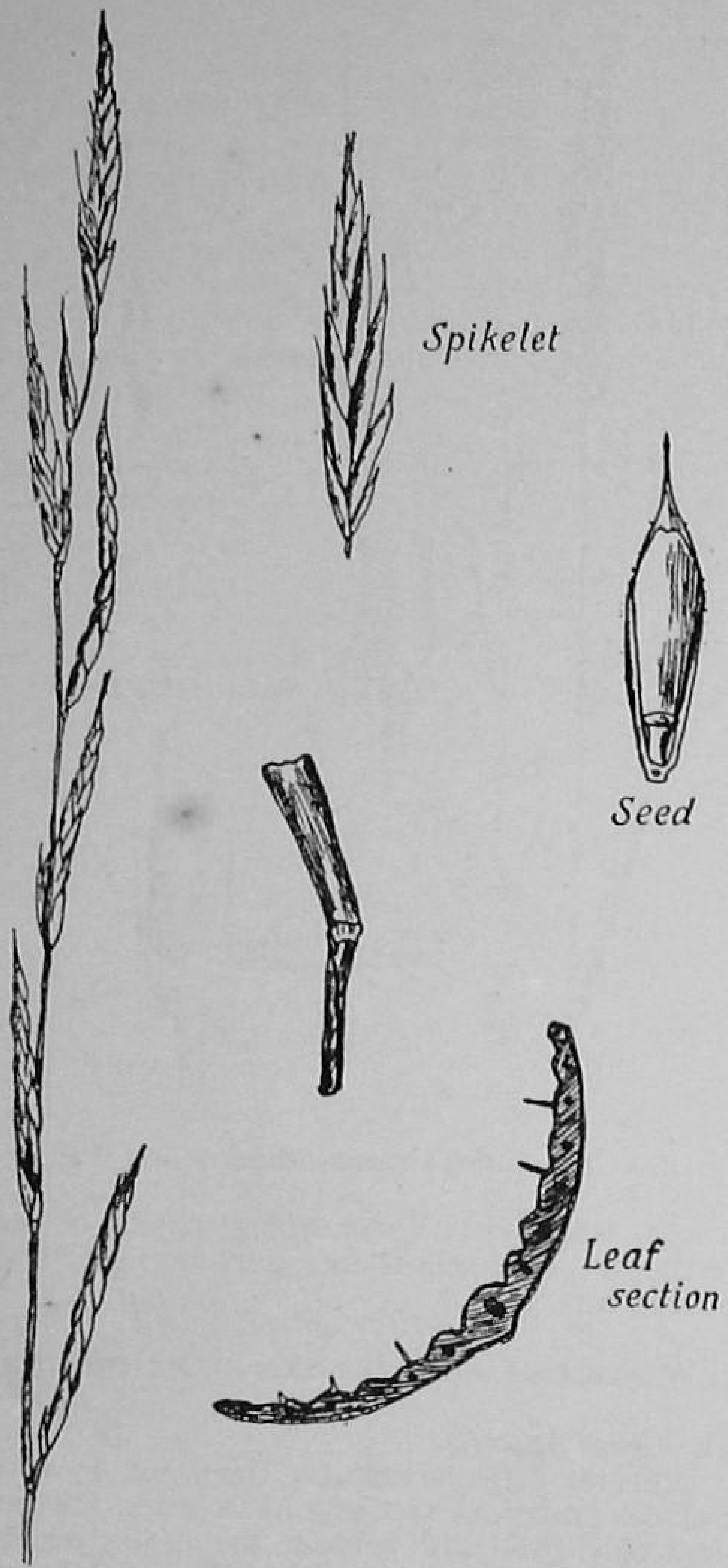

FIG. 24. Tor Grass or Heath False Brome Grass.

herbage is rather bitter, but is erect and early growing, and is thus short-lived under intensive conditions. On very dry gravelly soils it may be quite useful.

A variety of this grass, with numerous bulb-like enlargements at the base of the stems, is called onion couch, and is a bad weed of arable land.

3. Useful Pasture Grasses not Commonly Sown.

Sweet vernal grass (*Anthoxanthum odoratum*). This is easily recognized by the curious fringe of long hairs at the base of the blade, and by the short, triangular blade itself. When chewed the blade has a definite " hay " taste. It is a small tufted grass, with culms up to a foot long.

The ear is a close panicle. The spikelet is peculiar in having an outer, transparent pair of very unequal glumes, and an inner pair of brown hairy glumes, each with a characteristic awn.

Sweet Vernal Grass.

Sweet vernal grass in small amounts cannot be objected to in a turf, though its productions is very low. It is certainly a very early species, and its aroma may be of some value in hay. These points, however, do not justify its inclusion in the normal seeds mixture.

Yellow Oat Grass.

Golden (or yellow) oat grass (*Trisetum flavescens*). This species can best be identified by the downward pointing hairs on the leaf sheath, and the hairs which are found on both upper and lower surfaces of the leaves. The

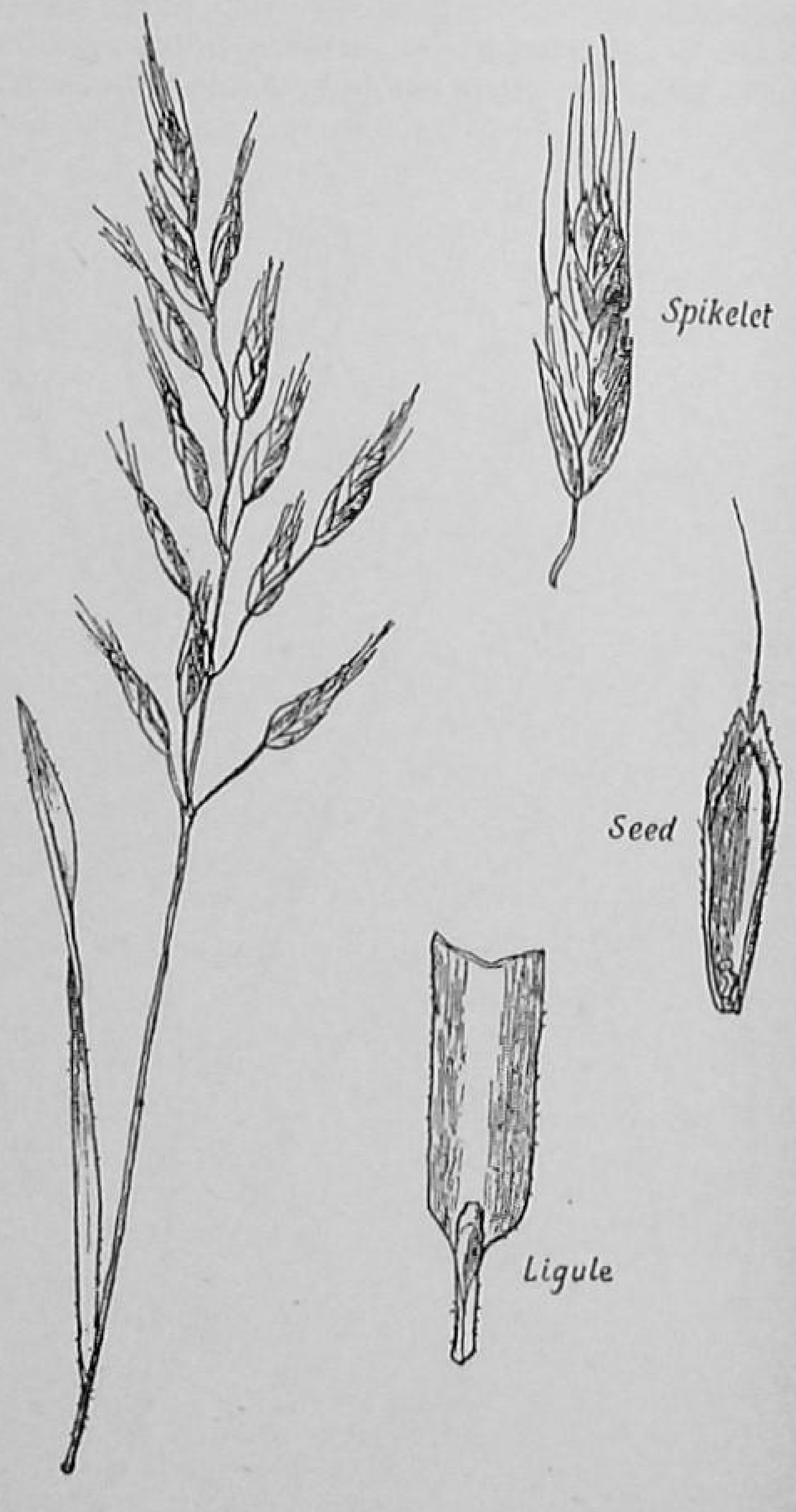

FIG. 25. Soft Brome Grass.

roots, too, may be distinctly yellow. It is a small plant, with a culm about 1–1½ feet long, and a delicate panicle superficially resembling tall oat grass (Fig. 20). Each spikelet has 2–3 flowers. The outer pale is split into two at the tip, and has a twisted, bent, dorsal awn.

The palatability of yellow oat grass is good, but it just has not the productivity required of a good farm grass. It is unobjectionable in old turf, but it is not worth sowing the seed in normal circumstances. Its seed is exceedingly dear and unreliable.

The Small Fescues.

The small fescues (*Festuca* spp.). These have the same general characteristics as meadow fescue, already described. Sheep's fescue (*Festuca ovina*) has almost solid leaves, and is very tufted. Red fescue (*F. rubra*) is an extremely variable plant, sometimes creeping by rhizomes, sometimes tufted. The ordinary person can lump all these different types into the omnibus class of small fescues, and forget about them when compounding his seeds mixtures for long leys—unless he happens to be farming poor, shallow land, when he *might* include some Chewing's fescue, which is a non-creeping variety of red fescue and is excellent for sports grounds and poultry turf.

FIG. 26. Yorkshire Fog.

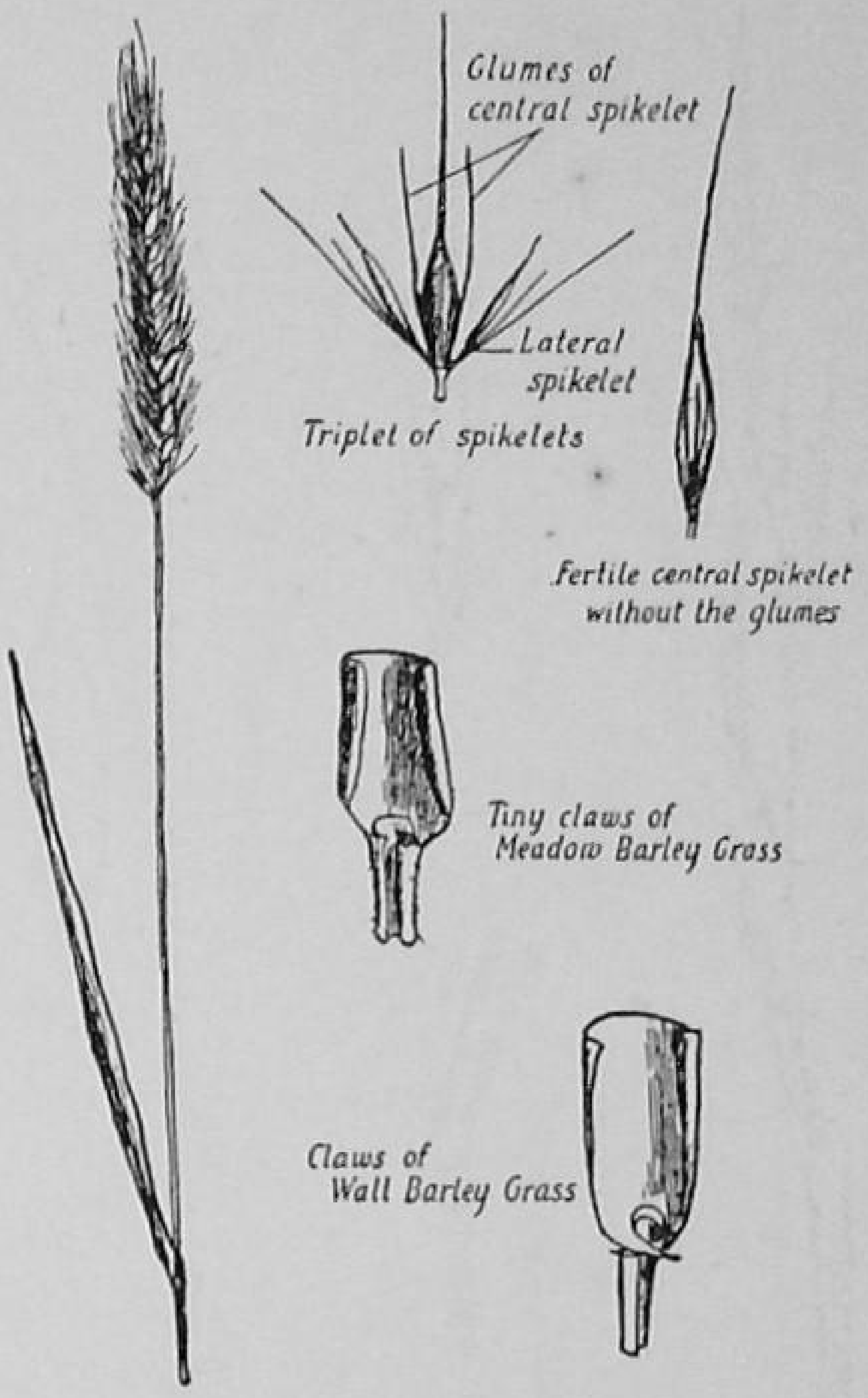

FIG. 27. Barley Grasses, Meadow and Wall.

4. WORTHLESS GRASSES COMMON IN OLD PASTURE.

The Genus Agrostis.

Bent grass (*Agrostis* spp.). The genus *Agrostis* includes numerous species and varieties, but we need only distinguish between the variety which creeps by underground stems after the style of couch grass (and which, like it, is a bad weed of arable land), and those varieties which are commonly found in second and third rate grassland almost throughout the country.

The shoots of *Agrostis* are cylindrical and slender; the leaf blades are long, thin and tapering to a fine point, ribbed on the upper surface. Claws are absent, and the ligule is variable. The common types in grassland often spread by surface runners. The ear is a very open, spreading, delicate panicle (Fig. 21), and may turn a purplish brown. The spikelets are very small, with only one flower apiece.

Agrostis is very objectionable because it is so unproductive and unpalatable. It starts growing late in the season and soon ceases. The term "Agrostis pasture" implies a poor, root-bound, unprofitable turf.

FIG. 28. Molinia or Flying Bent Grass.

Hair Grasses.

Hair grasses (*Aira* spp.). Two species may be a nuisance in turf. Tufted hair-grass (*Aira caespitosa*), also called tussock grass or hassock grass, forms large, circular tufts sometimes known as " bull-pates " or " snigglebeds." The grass both in this and in the early stage can be recognized by the very harsh leaves, with enormously high ridges on the upper surface. There are usually seven of these ridges, which can easily be seen with the naked eye if the leaf is cut across with a knife (Fig. 22). There are no claws, but the ligule is long and pointed. The culm may be up to 4 feet high. The ear is large and spreading, sometimes purplish, sometimes silvery grey. The tiny spikelet has 2–3 flowers, each with a long, hairy rachilla, and a bent, twisted awn arising from the base of the outer pale.

Wet, shady places favour this weed, which interferes with mowing and is a nuisance when the turf is ploughed up.

Wavy hair grass (*A. flexuosa*), is a small species with dark green, solid leaves and a shining panicle. It is most common on heaths, but also is found in very poor upland pastures (Fig. 23.)

Tor Grass.

Tor Grass (*Brachypodium pinnatum*). Tor grass, also called heath false brome, is widely distributed over poor grassland especially on clay and chalk soils. It is readily recognized by its light green foliage. The shoots are cylindrical; sheath and leaf hairy; no claws; blade erect, rough. The plant has a slight creeping tendency, which leads to the formation of the large circular, light green patches so characteristic of tor grass pastures in neglected situations. It is totally avoided by stock. Large ant-hills with tor grass growing out of them are frequently met with on stiff, poor clays. The ear is formed late in the summer, on a culm 1–3 feet long (Fig. 24). The large, many-flowered spikelets have extremely short stalks. A close relative, wood false brome, lives in shady places.

Brome Grasses.

Brome grasses (*Bromus* spp.). Brome grasses

FIG. 29. Nardus or Mat Grass.

are weeds, usually of arable land or of short leys. The general vegetative characters are, so to say, of a negative type—thin, ribless, hairy leaves; cylindrical shoot; leaf sheaths often striated or streaked with longitudinal lines; no claws. In flower, brome grasses can best be identified by the curiously bent rachilla; the oblique way in which the top of the rachilla and the base of the floret are sliced off (Fig. 25), and by the forked tip to the outer pale, just below which arises an awn. The ear is a panicle, and the spikelets contain numerous flowers.

Brome grasses are more likely to be found in rotation grassland and short leys than in the longer leys. Soft brome (*Bromus mollis*), and its close relatives, field brome and rye-like brome, are annual weeds very common in one-year leys. Erect brome is very similar, but is a perennial sometimes found in abundance in old turf. Sterile brome is exceedingly common in hedgerows, and is easily recognized by its large, drooping ear and by its long spikelets, each with a long awn; it seldom spreads into the open field. Wood brome is found in shady places, and has a culm reaching in some cases to a length of 6 feet.

Yorkshire Fog.

Yorkshire fog (*Holcus lanatus*). Yorkshire fog is perhaps the easiest of all grasses to recognize. It has white leaf sheaths with longitudinal pink stripes. The whole plant is covered with soft, woolly hairs. The panicle at first is closed and greenish, but later opens out and turns pink. Each spikelet has two flowers, and on the upper one is an unmistakable awn, curved back like a fish-hook (Fig. 26).

Rightly looked upon as a weed in lowland grassland, this species is sometimes used as a pioneer plant in the reclamation of very poor hill grazings. The seed used in such cases comes from the cleanings of other grasses. Yorkshire fog is palatable in the very early spring, but subsequently is totally neglected for better quality grasses. A close relative is *Holcus mollis*, which creeps by surface runners, usually in shady places.

Barley Grass.

Barley grass (*Hordeum* spp.). Meadow barley grass (*H. pratense*) is found abundantly only on stiff land. The shoot is cylindrical, lower sheaths hairy, upper ones often without hairs. Leaf hairy above, shining and almost hairless below. Claws at base of leaf small. The ear closely resembles that of the cultivated barley (Fig. 27). Meadow barley grass is sometimes so abundant in moist, stiff pastures that it forms the bulk of the herbage; this is no recommendation, however, for its yield is very small, and measures should be taken to raise the fertility of such grassland, when barley grass will disappear.

A larger relative, with conspicuous claws, is Wall barley grass, which occurs only in dry, sheltered places, such as at the bases of walls and fences.

Flying Bent.

Molinia or Flying Bent (*Molinia caerulea*). This useless grass can be identified by its tough, cord-like roots, which are much thicker than those of other grasses; by its long, tapering leaves with whitish hairs on the upper surface, and by the ring of hairs which represents the ligule. The flower stalk has its lowest nodes somewhat swollen. During the winter *Molinia* loses its leaves—this habit gives it its common name flying bent.

The panicle does not expand (Fig. 28); the spikelets arise alternately on the stalk, and are usually purplish in colour; there are 2 or 3 flowers. The rachilla is bent at the top. Both the stigmas and the anthers of the flower are purplish in colour.

Molinia is plentiful on moors, in wet upland grazings, hill pastures and similar places. The term " a *Molinia* pasture " conjures up in the mind of a grassland enthusiast just as definite a picture of unfertility as does the term " an *Agrostis* pasture."

White Bent.

Mat grass (*Nardus stricta*). Also called white bent, this species has stringy, tough roots, and almost solid, needle-like leaves with five ridges on the inner, or upper surface. It is densely tufted and devoid of hairs. The culm is about 6 inches long, and the ear is one-sided, the stalkless spikelets forming a single row (Fig. 29). There are no glumes, and only one flower in each spikelet.

Nardus is found most plentifully on very acid land; both *Nardus* and *Molinia* form dense mats which respond very slowly to surface treatment.

HOW TO RECOGNIZE THE COMMON GRASSES

In this section great emphasis is rightly placed upon the importance of being able to recognize individual grasses and this section is a very practical section because it deals with the recognition of grasses which are of special interest to the farmer, especially to the farmer who wishes to have Good Grassland.

There are two special Keys here which enable the student to recognize grasses at any state of development.

Gramineae.

GRASSES, like other plants, are named and classified in the first case according to the structure of their flowers. Grasses belong to the great family (or Natural Order) Gramineae, which for convenience is split up into smaller groups each called a Genus (plural=Genera). The unit of a genus is the Species, composed of innumerable individuals all closely resembling one another, though not exactly alike. For example, all rye-grasses are grouped into the Genus *Lolium* because their flowers and flower heads are so similar. But Italian rye-grass has awns on its outer pales and is biennial in habit, while perennial rye-grass has no awns, and is longer lived. For these and other reasons the former plants are said to constitute the species *multiflorum* and the latter to form the species *perenne.* Hence the scientific name for Italian rye-grass is *Lolium multiflorum*, and for perennial rye-grass *L. perenne.*

It is much easier to identify a grass when it is flowering than it is when no flowers are present. The first of the keys—given here—enables the beginner, after a little practice, to put into its correct genus each of the grasses most commonly found in British grassland. To identify the species it is then necessary, in certain instances, to refer either to Key 2, or to the description given in the letterpress of this book.

Key.

No key is perfect, and more is not claimed for these two examples than that they are a guide to the identification of common grasses. At first the student should work conscientiously through the key, but later, of course, all sorts of short cuts will suggest themselves. The first thing to do is to decide whether the specimen falls into class A or B (or C); then if it is included in sub-class 1 or 2.

KEY 1.

THE RECOGNITION OF COMMON GRASSES WHEN IN FLOWER

A. EAR IS A SPIKE. (That is, the spikelets either have no separate stalk, or else a very short stalk indeed.)

1. ONE ROW OF SPIKELETS, ear one-sided — *Nardus* (Mat-grass)
2. TWO ROWS OF SPIKELETS
   - i. One glume to each spikelet; ear flat — *Lolium* (Rye-grass)
   - ii. Two glumes per spikelet; notches distinct — *Agropyrum* (Squitch)
   - iii. Two glumes per spikelet; notches not distinct — *Brachypodium* (Tor-grass)
   - iv. Three spikelets at each notch: long awns — *Hordeum* (Barley-grass)
     (*Phleum* (timothy) and *Cynosurus* (dogstail)—might come here, but see below).

B. EAR IS A PANICLE. (That is, the spikelets have distinct stalks joining them to the main stem.)

1. EAR CYLINDRICAL
   - (*a*) Soft to touch, very hairy; long awn — *Alopecurus* (Foxtail)
   - (*b*) Harsh to touch; no awn, but glumes with sharp keel and tip — *Phleum* (Timothy)
   - (*c*) Ear one-sided; central stalk wavy; spikelets in clusters at each joint — *Cynosurus* (Crested Dogstail)
   - (*d*) Four glumes per spikelet; inner pair brown when ripe; very hairy; bent awn — *Anthoxanthum* (Sweet Vernal)
2. EAR MORE OR LESS SPREADING
   - (*a*) Resembling the foot of a bird; spikelets in clusters — *Dactylis* (Cocksfoot)
   - (*b*) Ear very delicate; one flower per tiny spikelet — *Agrostis* (Bent grass)
   - (*c*) Two flowers per spikelet
     - i. outer pale of upper flower with " fish-hook " awn — *Holcus* (Yorkshire Fog)
     - ii. outer pale of lower flower with strong, bent awn — *Arrhenatherum* (Tall Oat grass)
   - (*d*) more than two flowers per spikelet
     - i. outer pale without awn or awn point; usually a " web " of fine hairs at its base — *Poa* (Meadow grass)
     - ii. as above, but no " web "; stigma, anthers (and often whole ear) purple — *Molinia* (Flying Bent)
     - iii. awn on back of outer pale, which is forked at tip — *Trisetum* (Golden Oat)
     - iv. awn at base of outer pale — *Aira* (Hair grass)
     - v. awn at very tip of outer pale; rachilla outstanding, with cap — *Festuca* (Fescue)
     - vi. awn just below tip of outer pale; rachilla bent — *Bromus* (Brome grass)

KEY 2.

THE RECOGNITION OF COMMON GRASSES WHEN NOT IN FLOWER

(*Note:* Certain grasses, such as Crested Dogstail and Perennial Rye-grass have shoots which at times appear flattened, and at other times cylindrical.)

A. LEAVES BRISTLE-LIKE

i. roots tough and stringy; tufted	MAT GRASS (*Nardus*)
ii. leaves almost solid; ligule broader than leaf base; tufted	WAVY HAIR GRASS
iii. tiny upright projections at leaf base; tufted	SHEEP'S FESCUE
iv. basal sheaths pink; creeping underground stems	CREEPING RED FESCUE

B. LEAVES FOLDED, SHOOT FLATTENED

1. WITH AURICLES, OR CLAWS

Lower sheaths pink; blade glossy below, dull above; ligule very small	PERENNIAL RYE-GRASS

2. WITHOUT AURICLES OR CLAWS

(*a*) BASAL SHEATHS BRIGHT YELLOW; leaves dull, dark green, edges of blades slightly up-curved, prominent ribs; no hairs; (shoot sometimes cylindrical)	CRESTED DOGSTAIL
(*b*) LEAVES BROAD, tips drawn out to sharp points; shoot much flattened; sheaths with strong keel, often pinkish on one side, green on other; ligule large	COCKSFOOT
(*c*) LEAVES NARROW, often with a distinct " white line " on each side of mid-rib; tip boat-shaped	
i. ligule very large; blades dull, often crinkled	ANNUAL MEADOW GRASS
ii. ligule pointed; blade glossy below; tufted, but possibly with thin surface runners; culm rough	ROUGH MEADOW GRASS
iii. ligule blunt or absent; basal leaves very long, with parallel sides and blunt tip; possibly with stout underground, whitish, creeping stems; culm smooth	SMOOTH MEADOW GRASS

C. LEAVES ROLLED, SHOOT CYLINDRICAL

1. WITH AURICLES OR CLAWS

(*a*) PLANTS WITHOUT HAIRS; LOWER SHEATHS PINK	
i. blades dull above, glossy below; base of leaf margin smooth; basal shoot bud sharply pointed	ITALIAN RYE-GRASS
ii. similar, but basal shoot bud rounded at tip	MEADOW FESCUE
iii. auricles creamy white, fringed with stiff hairs; leaves with pronounced ribs; coarse tufts	TALL FESCUE
(*b*) PLANTS HAIRY	
i. strong, white, underground runners; hairs chiefly on lower sheaths and upper surface of leaves	TWITCH (COUCH GRASS)
ii. auricles very small; blades hairy above, glossy below	MEADOW BARLEY GRASS
iii. auricles large, overlapping; blades hairy both sides	WALL BARLEY GRASS

2. WITHOUT AURICLES OR CLAWS

(*a*) PLANTS WITHOUT HAIRS	
i. base of stem swollen, often tinged with violet beneath the pale brown sheaths; leaves pale green, stiff (sometimes with a few short hairs at base)	TIMOTHY
ii. basal sheaths very dark brown; underground runners may be present; blades dark green	MEADOW FOXTAIL
iii. base of stems sharply bent at each joint; damp situations	FLOATING FOXTAIL
iv. blades with (usually 7) very high, sharp, harsh ribs; ligule long; big, coarse tufts when old	TUSSOCK GRASS
v. blades ribless, thin; ligule long; delicate underground or above-ground runners may be present	BENT GRASS (*Agrostis*)
(*b*) PLANTS HAIRY	
i. sheaths white with pink veins; very hairy	YORKSHIRE FOG
ii. roots tough and stringy; blades tapering to a long point; ligule represented by hairs	FLYING BENT (*Molinia*)
iii. roots bright yellow; basal joints often swollen; sometimes almost without hairs	TALL OAT GRASS
iv. hairs on sheath pointing downwards	GOLDEN OAT GRASS
v. long hairs at junction of blade and sheath giving appearance of claws; blades short, triangular; tufted; characteristic hay-like taste when chewed	SWEET VERNAL GRASS
vi. Blades light green, tending to roll up; slightly creeping, often in large circular patches	TOR GRAS; (*Brachypodium*)
vii. leaves thin and soft, with downy hairs	BROME GRASSES

LEGUMINOUS PLANTS

Proceeding to the study of leguminous plants found in grassland, their special value to the farmer is described and their special characteristics are indicated. Subsequently the true clovers used in agriculture receive enough attention to enable the student to distinguish between them in the field, while the merits of the various cultivated strains are discussed. Some important plants related to the true clovers next receive attention, thus concluding this brief preliminary study of the individual plants making up the flora of grassland.

Family Leguminosae.

Leguminous plants, those belonging to the botanical family Leguminosae, are perhaps rather better known than the grasses because they are more easily recognized, and because fewer species are found in grassland.

All leguminous plants bear on their roots small tubercules, or nodules, in which dwell for a time countless numbers of bacteria which absorb nitrogen from the air in the soil. This nitrogen is eventually taken up by the plant, with the result that all parts of it, root, stem, leaves and seed, are relatively much richer in protein than are the corresponding portions of non-leguminous plants. Legumes, therefore, not only give a protein-rich herbage, but through the decay of the roots, enrich the soil with organic nitrogen. There is also evidence to show that there is an escape, or secretion, of nitrogenous substances from the root during the life of the plant, with a consequent stimulation of the growth of grasses situated in the immediate vicinity of the legume. It is this relative richness in nitrogen which makes it imperative to have leguminous plants of some sort in a turf.

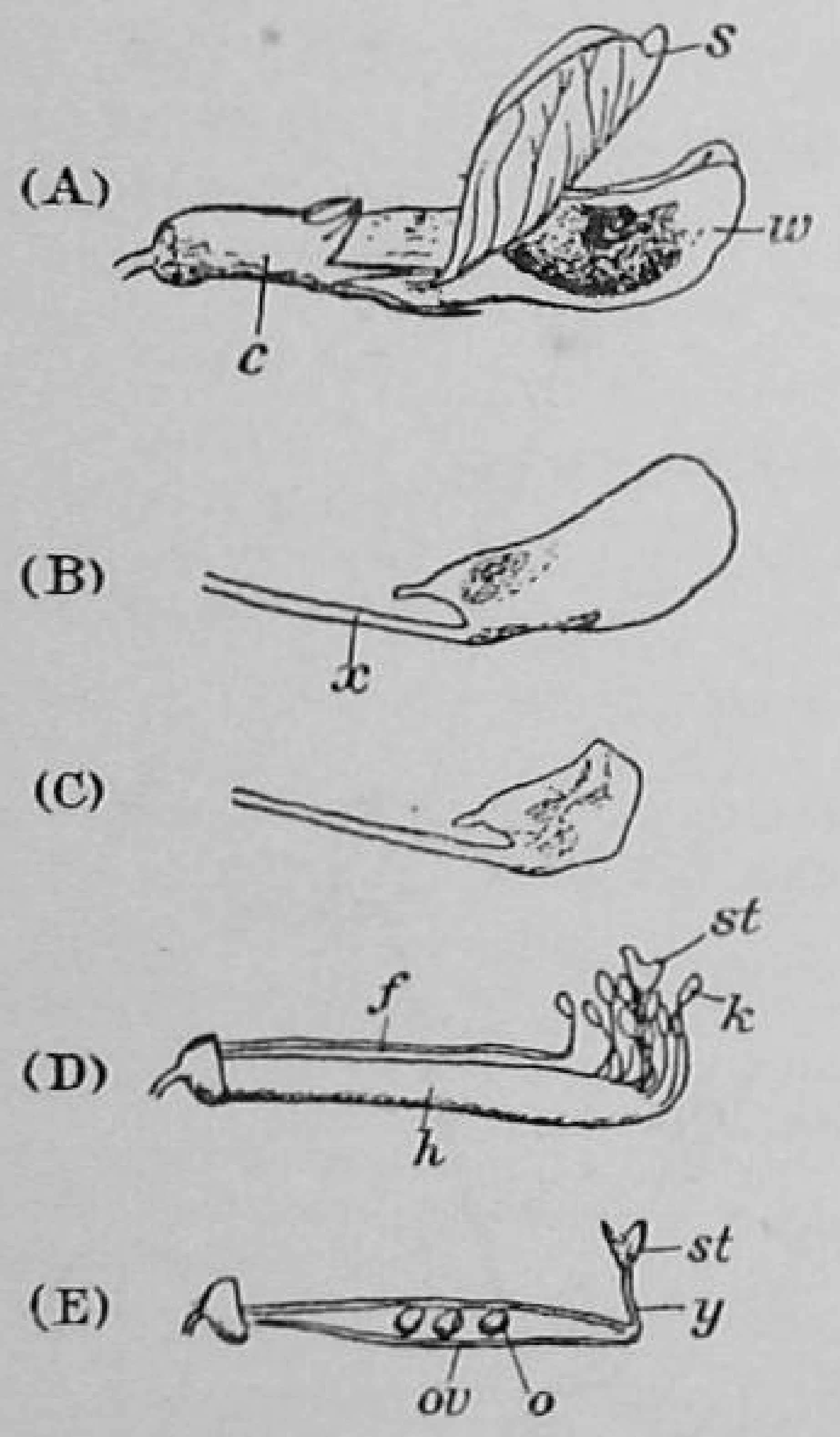

Fig. 30. A Typical Leguminous Flower—Field Bean. A. Complete flower. B. Wing petal. C. Keel petal. D. Stamens. E. Pistil. c, Calyx; s, Standard petal; w, Wing petal; x, Claw of wing petal; f, Free stamen; k, Anther; h, Stamen sheath; st, Stigma; o, Ovary; ov, Ovule; y, Style.

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The Flower.

The main feature which distinguishes leguminous plants from non-leguminous plants is the flower, which is illustrated in Fig. 30. There is a tubular calyx, usually with five teeth; a corolla consisting of one large standard petal, two wing petals, and two keel petals more or less joined together. There are ten stamens, joined at the base into a sheath surrounding the ovary. The ovary contains either one or several potential seeds, and has a longish style bearing the stigma.

The principal grassland legumes which need to be recognized are the true clovers, the medicks, and the birdsfoot trefoils. Weeds, such as rest harrow, wild vetches, dyer's greenweed, broom and gorse are common in certain types of grassland.

Clovers.

True Clovers (Genus *Trifolium*) are easily identified by the trifoliate leaf consisting of a terminal leaflet and two opposite lateral leaflets. At the base of the main leaf stalk is a pair of special leaves, called stipules. These stipules are a useful guide in recognizing clovers. The midrib of the clover leaflet never projects beyond the edge of the leaf—this at once distinguishes clovers from medicks (Fig. 32). The seed pod is never twisted, as it is in the medicks.

The commonest clovers are:

Red clover	*T. pratense.*
Alsike clover	*T. hybridum.*
White clover	*T. repens.*
Yellow suckling clover ..	*T. dubium.*
Strawberry clover ..	*T. fragiferum.*
Subterranean clover ..	*T. subterraneum.*

Red clovers are always more or less erect, and do not have the runners that are so typical of white clover. The stipule is broad, with a very abrupt, sharp point (Fig. 31.) Hairless types and very hairy types are to be found. Usually there is a bright coloured curved band on the leaves, and the margin or edge of the leaf is never toothed. The flower is typically red, but white plants are not uncommon. Three kinds of red clover are found.

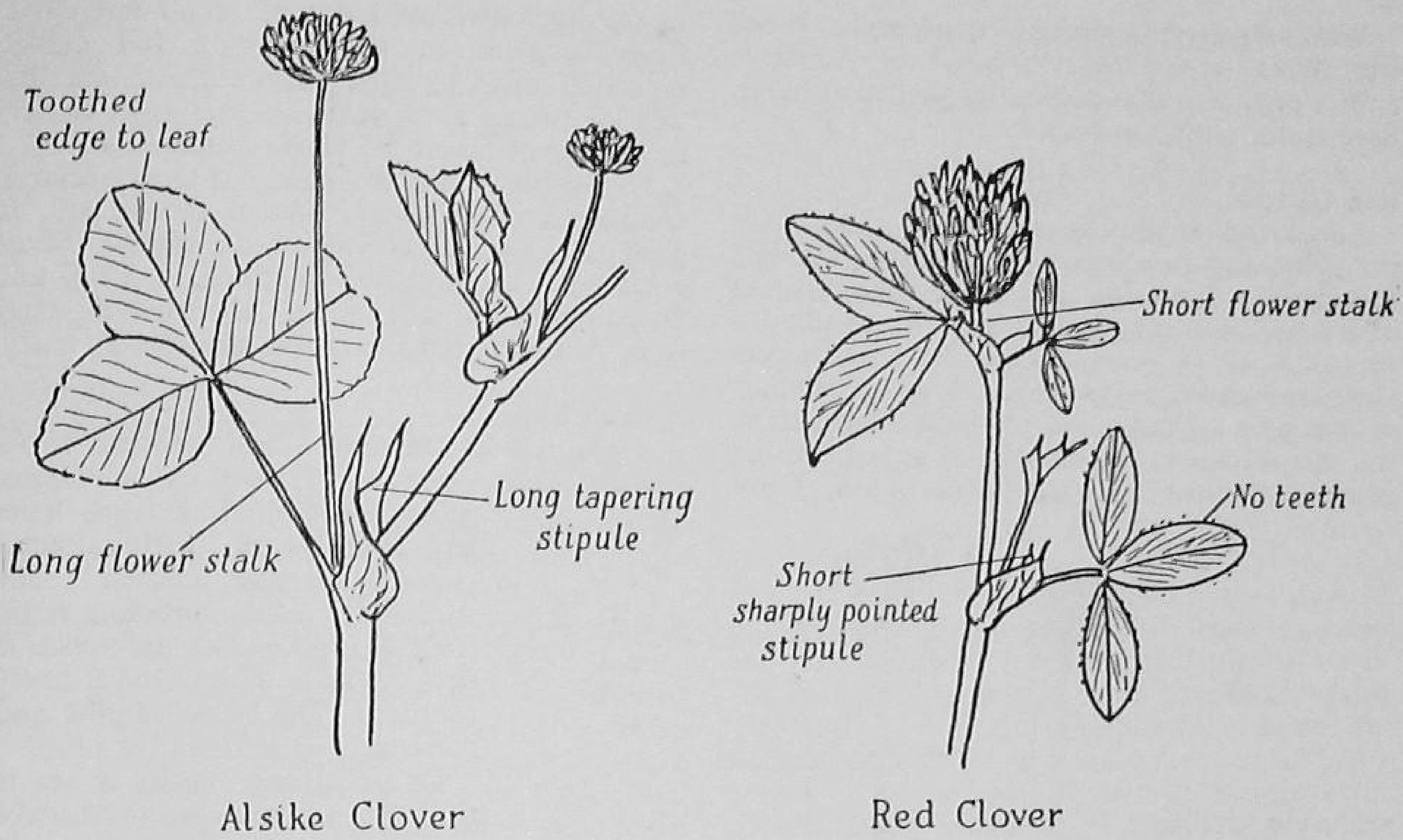


FIG. 31. Red Clover and Alsike Clover.

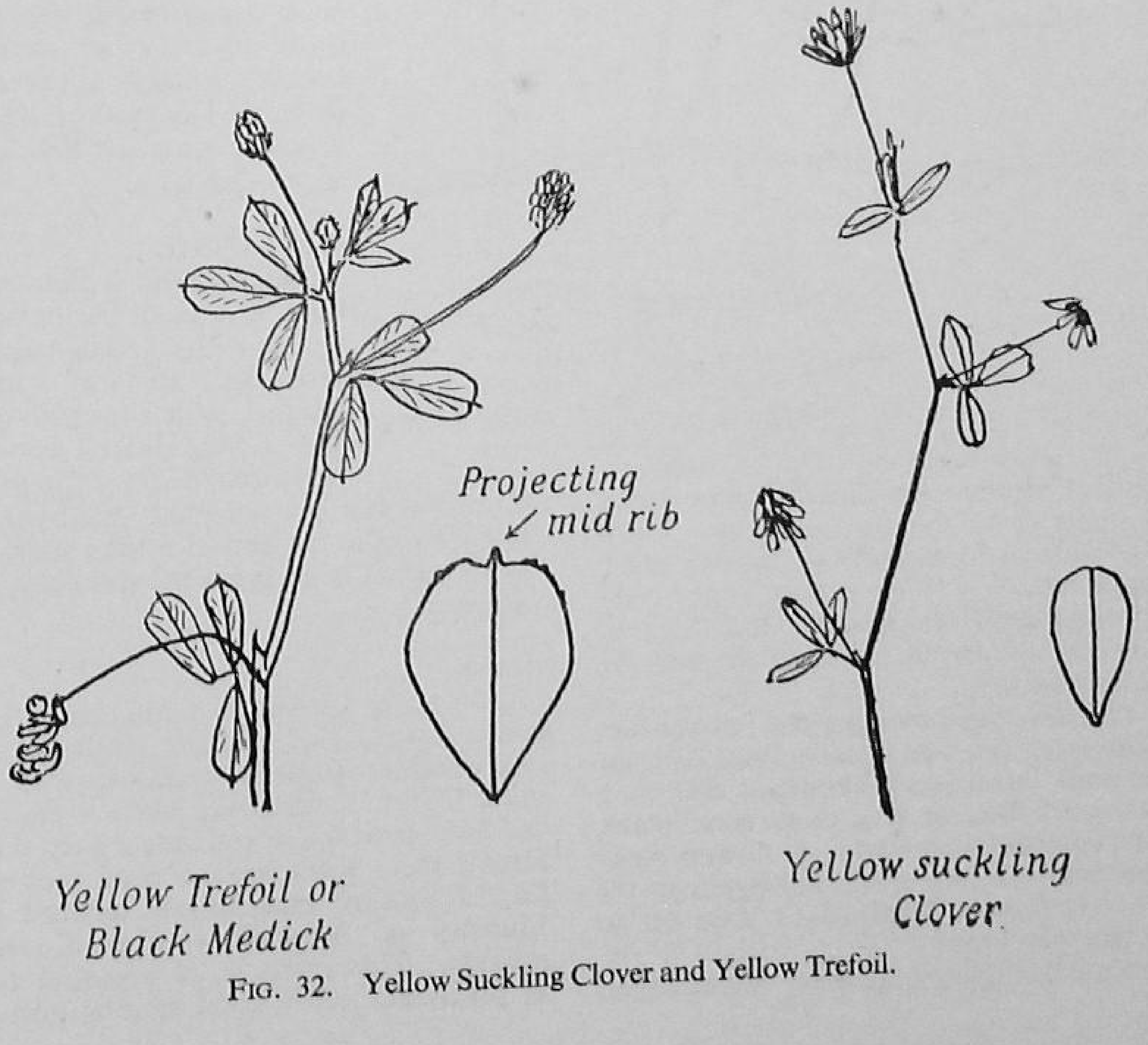


FIG. 32. Yellow Suckling Clover and Yellow Trefoil.

Wild red clover is native to many soils. It has wiry stems and few leaves; it is not very palatable and is of little value despite its persistent habit. Seed is not on the market.

Red Clovers.

Late flowering red clover has many more stems per plant, and more leaves per stem than the wild red clover. Individual plants are very compact and dense, and may live under farm conditions up to 4 or 5 years. Late red clovers are sometimes called single-cut red clovers, since they do not give anything like so much aftermath as the early-flowering red clovers. Late red clovers graze well, and also give good yields of hay. There are numerous strains, the British types being generally superior to the foreign types. Extra late strains such as Montgomery, Cornish Marl, and Aberystwyth S. 123 have been found very useful in long leys. In general, the late red clovers are less susceptible to clover rot than the early red clovers.

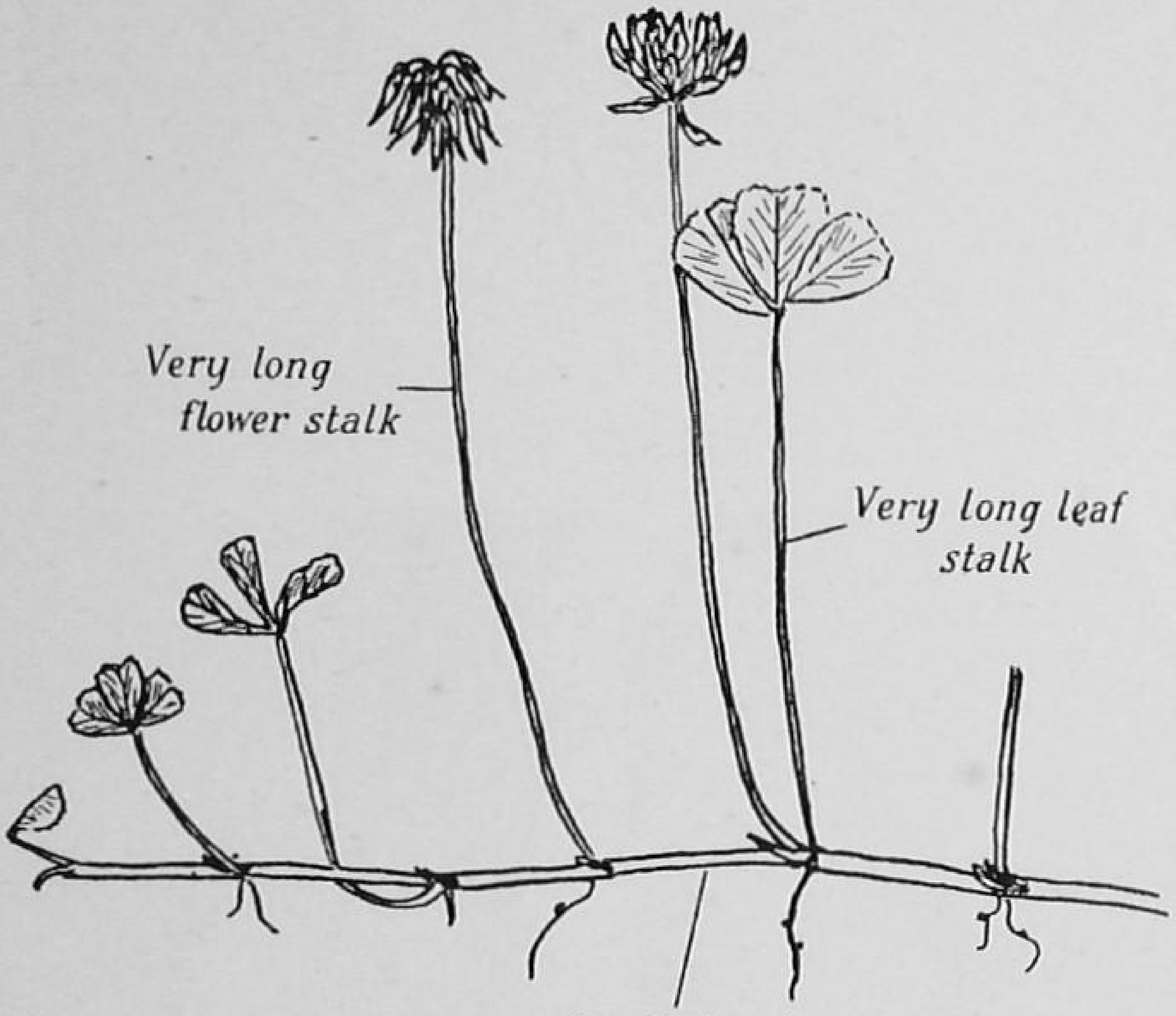


FIG. 33. White Clover.

Broad red, or early-flowering red, clover dies out rapidly after the first season following the sowing of seed, but it yields abundant aftermath during its short life. It is a more erect plant, and not so compact in growth. It flowers twice a year, once in the hay crop, and again in the aftermath. It flowers from 10–14 days earlier than the late red clover.

It is practically impossible for any but an expert to tell an individual plant of broad red clover from a plant of late-flowering red clover, especially after grazing. The chances are that in a ley two or more years old there will be very few plants of broad red clover remaining.

Numerous strains of broad red clover exist in commerce. English and Welsh strains are, in general, superior to imported strains. Some good types come from New Zealand, Chili and Scandinavia. S. 151 is an Aberystwyth early type. American red clovers are usually very hairy.

Alsike Clover.

Alsike clover resembles red clover in its upright habit, but its foliage is a lighter green and quite free from hairs and there is no light-coloured crescent on the leaflets. The stipule has a long, tapering point (Fig. 31). Another difference is that the edge of the leaf is finely toothed. The flower is pink and there are 1–3 seeds in the pot.

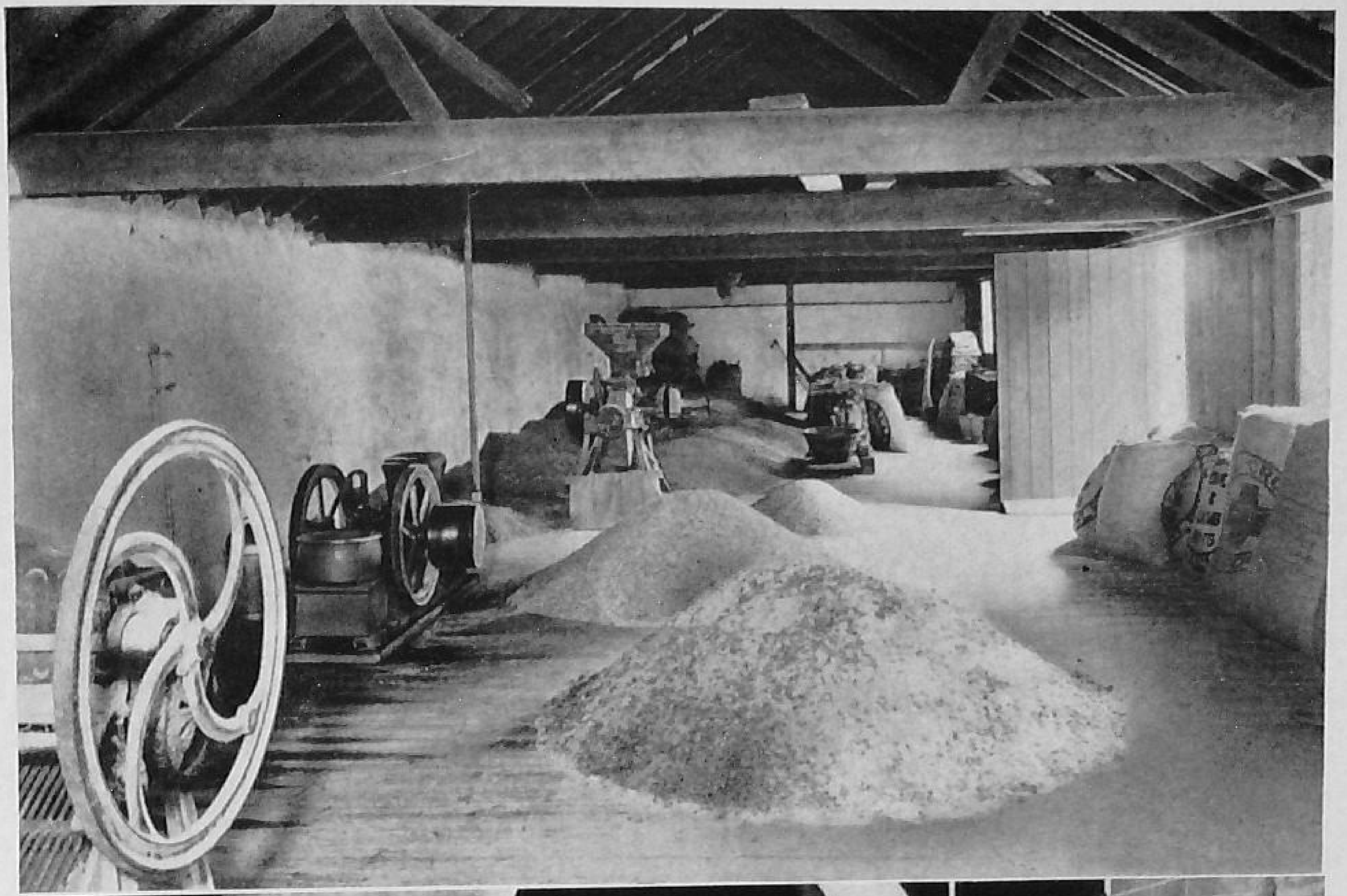
On good soils, alsike clover is probably not quite so productive as red clover, nor is its root system so extensive. It persists 3–6 years and, on certain soils—especially lime-deficient soils and on some clays—it is superior to red clover. The inclusion of a small quantity of seed of alsike in a prescription, especially for short leys, is an excellent insurance against a failure of red clover. The seed of alsike clover is only about half the size of that of red clover.

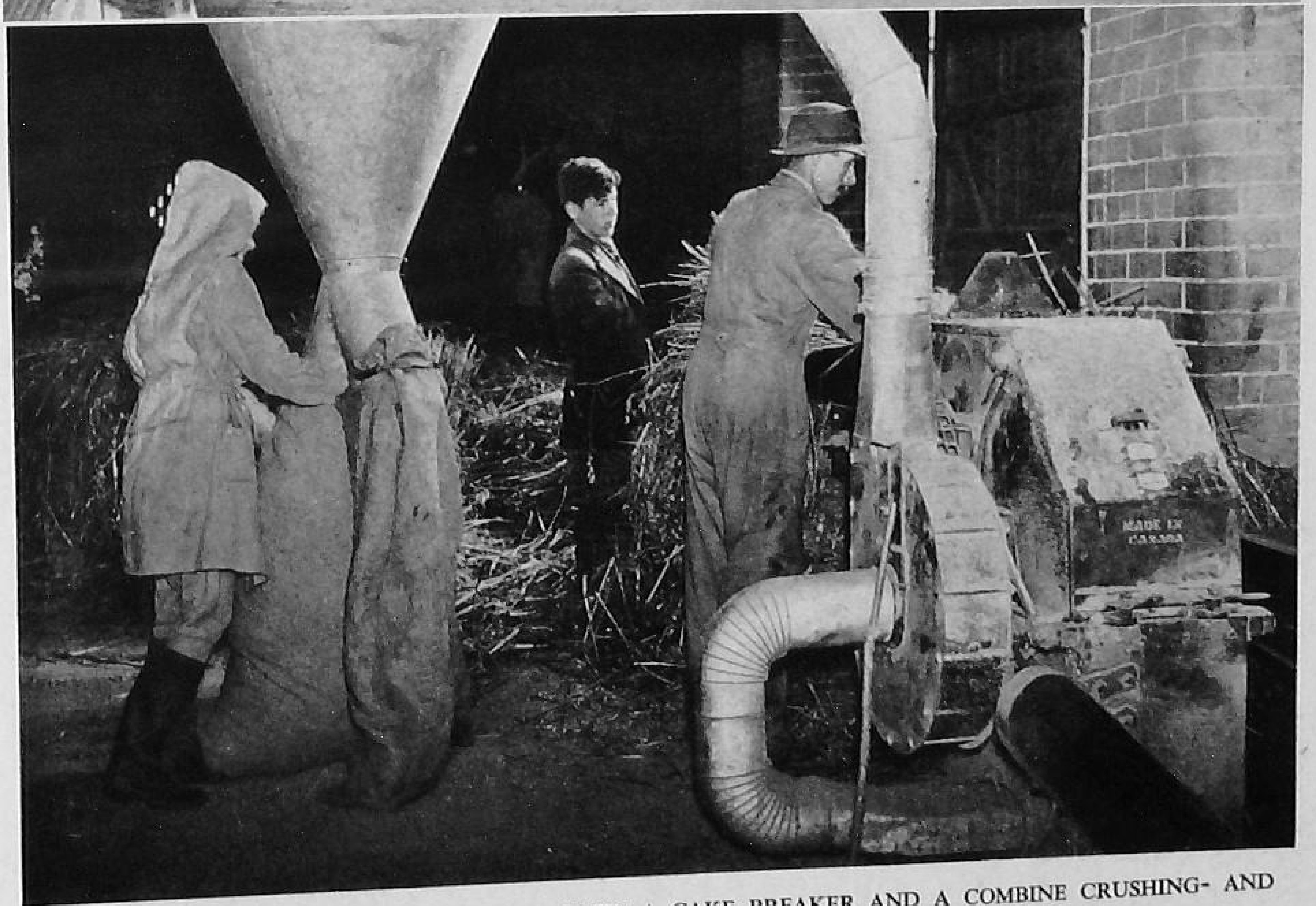
White Clover.

White clover is the mainstay of long leys and permanent grass. It is easily recognized by its prostrate, surface runners, or stolons, which root at the nodes; by its long-stalked leaves, which are toothed along the margin and are more or less heart-shaped; and by the head of white flowers at the end of a long stalk (Fig. 33). The following main types of white clover exist in commerce:—

Strains.

Wild white clover is a long-lived type, with small leaves and slender stolons. There is considerable variation among various strains of white clover, some being more vigorous, larger and more productive and longer lived than others. Strains from Kent have a good reputation, but English strains, especially if certified under the Ministry of Agriculture scheme, are usually reliable. This plant is an essential component of practically every good grazing pasture, but a





Above: A MIXING-ROOM AND GRANARY, WITH A CAKE BREAKER AND A COMBINE CRUSHING- AND GRINDING-MILL

Below: A HAMMER-MILL WHICH HAS A CAPACITY OF 3 TONS AN HOUR

Farmer & Stock-breeder Photographs

Above: A HAY ELEVATOR BEING USED TO LOAD SHORT GRASS ON TO A SILAGE STACK
Farmer & Stock-breeder Photograph.

Below: A TYPE OF WAGON LOADER WHICH CAN BE USED EQUALLY WELL FOR HAY OR FOR SHORT GRASS
Photo: H. J. Hine.

field entirely composed of wild white clover would not be very productive. A good balance between grasses and clovers is needed because wild white clover gives practically no keep in winter, and does not start growing until early summer. Some types of wild white clover are very small in the leaf as well as being late in starting growth; consequently there is a growing tendency to use larger-leaved, earlier-growing types of wild white clovers in ley of about 3–5 years duration.

S. 100 white clover is perhaps the best known representative of this type. It has stout runners which cover the ground very quickly, and it produces very much more foliage than the wild white clovers, so much more that, in conjunction with perennial rye-grass alone, it can give a very useful and very nutritious cut of hay as well as supremely good grazing. It is not truly permanent, but it will last successfully for at least six or seven years on suitable land.

New Zealand certified permanent pasture, and certified mother, white clover resembles Aberystwyth S. 100, though they are not quite so productive.

Dutch white clover has the same general botanical characters as the above, but the runners do not root at the nodes in the same way, and the plant dies out very quickly. Its use has greatly declined of recent years.

Lodi, or Ladino clover, is a giant form of white clover which has not proved successful here, though in parts of U.S.A. it seems to be very useful in conjunction with rye-grass.

Yellow suckling clover is a small annual plant with fibrous roots, and narrow leaves. The stems are thin and wiry, and as they get older often turn reddish brown; on this account the plant is sometimes called red suckling clover in the eastern counties. The flowers are small and yellow (Fig. 32). Except on very dry, gravelly soils this plant must be looked upon as a weed, which is specially obnoxious where white clover is being grown for seed; the seeds of these two species are not easily separated during cleaning operations.

Strawberry Clover.

Strawberry clover closely resembles white clover in general structure and creeping habit. It has pinkish white flowers and, after flowering, the head swells up into a rounded, pinkish structure not unlike a strawberry. The plant is found in grassland close to the sea and is easily mistaken for wild white clover.

Subterranean Clover.

Subterranean clover is occasionally met with in this country. It has stems which lie on the top

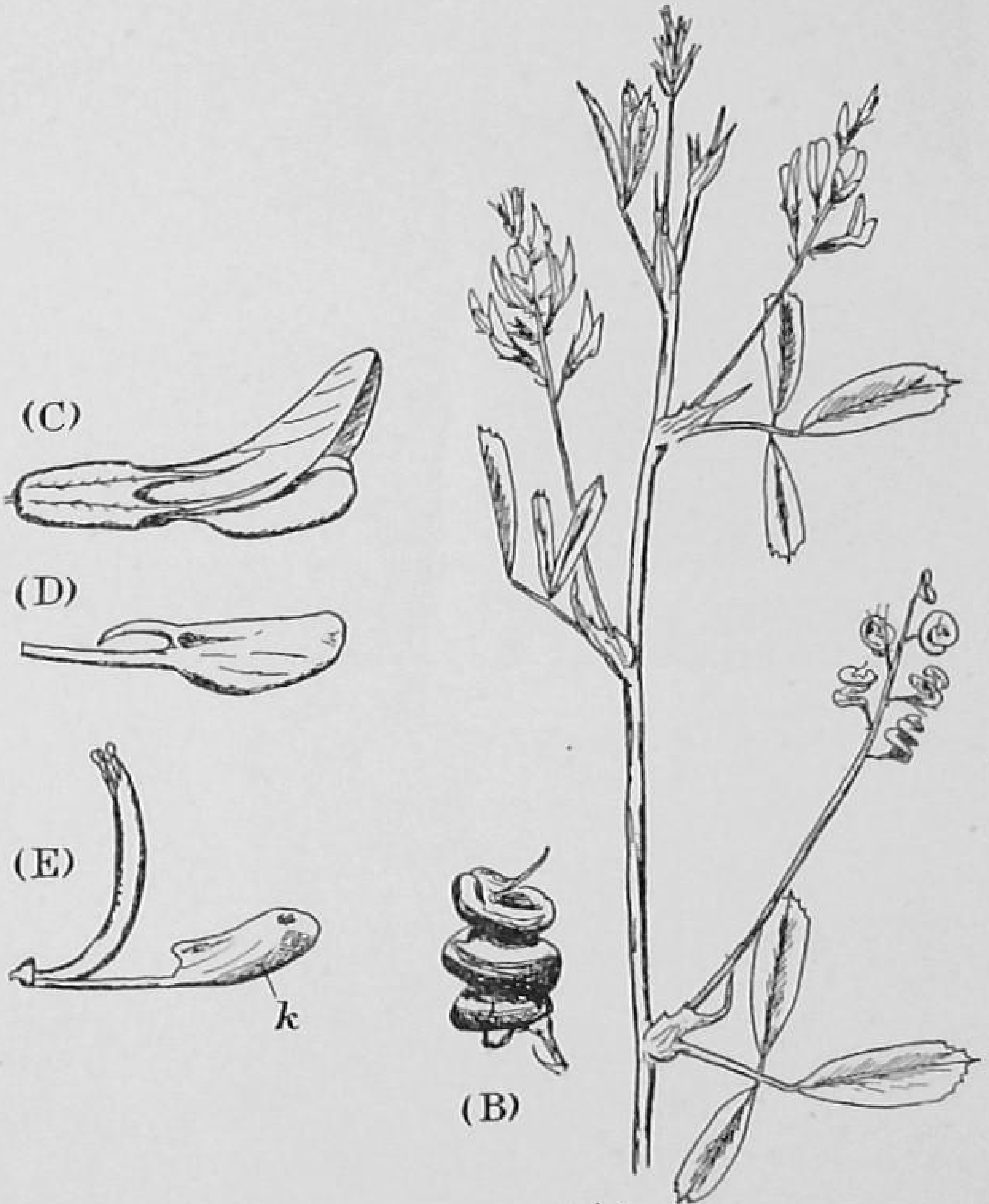


FIG. 34. Lucerne or Alfalfa.

A. Part of a plant. B. Spirally coiled fruit. C. Flower. D. Wing petal. E. The immature pod and enclosing stamen sheath curve backwards after removal of standard and wing petals. k, keel petal.

Reproduced from the Author's "Leguminous Forage Plants," by permission of the publishers, Messrs. Edward Arnold & Co.

of the ground, but without rooting at the nodes like white clover. The flowers are relatively large, 2–5 in a cluster. After flowering the heads turn down and bury themselves in the soil, forming numerous anchor-like fibres to hold them fixed in position. The seed is very large and dark in colour. The plant is of no value in this country, though it is used extensively in Australia.

Trefoil.

Trefoil (Yellow trefoil, or black medick) can be distinguished from clovers by the way in which the mid-rib of the leaf projects to form a sharp point; the terminal leaflet has a longer stalk than the two lateral leaflets (Fig. 32). The yellow flowers are collected into loose heads, and the tip of the seed pod becomes twisted as ripening takes place; the pod turns black, hence the name black medick. These points at once separate trefoil from yellow suckling clover.

Trefoil is of limited value in a pasture. It lasts one or two years but produces seed so freely that it may keep on re-establishing itself. Its foliage is not so palatable nor so nutritious as that of the true clovers, while it does not contribute much to the hay crop unless specifically sown for the purpose. It likes chalky soils best. Seed is usually cheap, but it is not advisable to use more than one pound per acre for leys longer than one year.

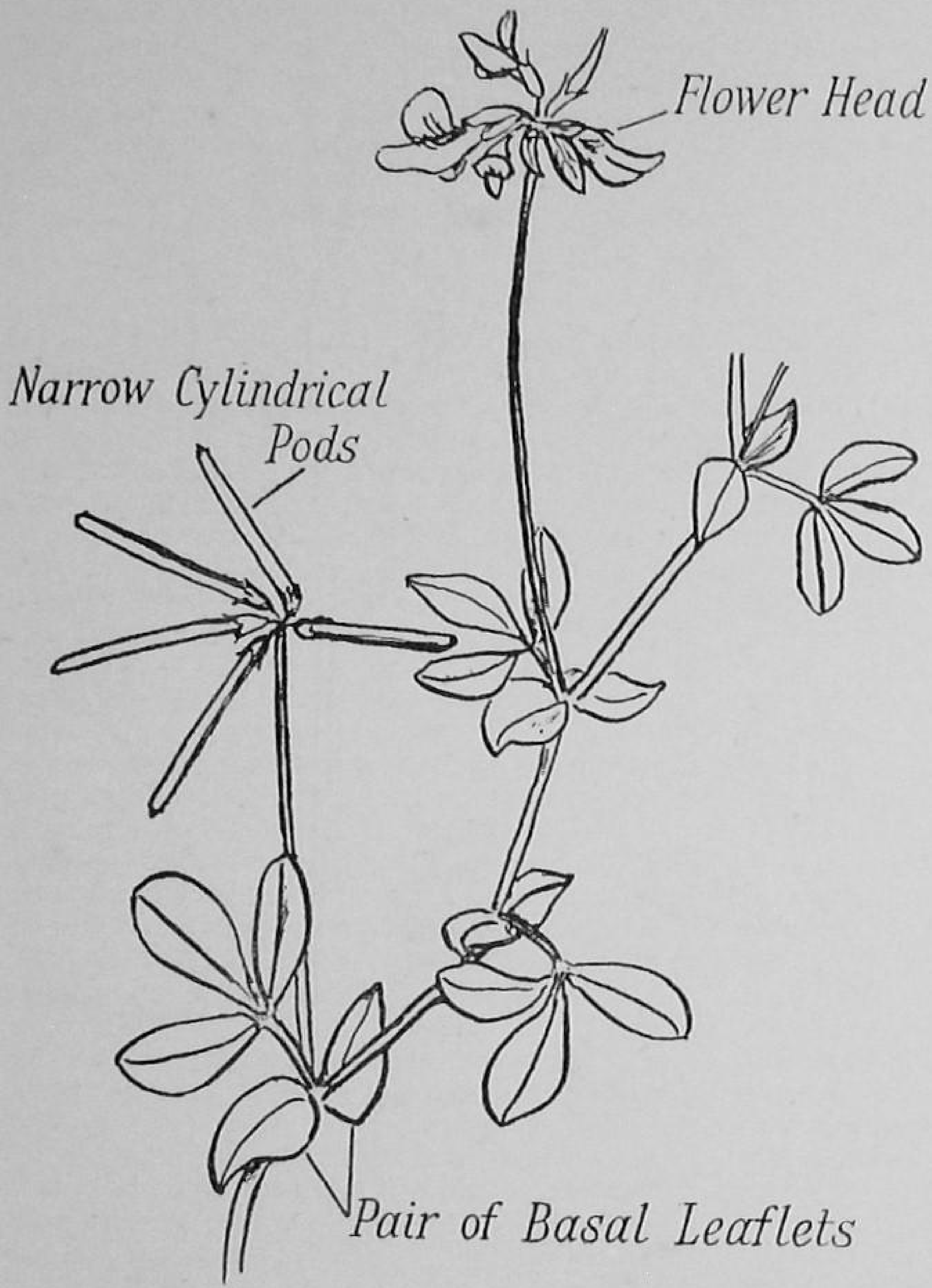


FIG. 35. Birdsfoot Trefoil.

Lucerne.

Lucerne has the characteristic projecting mid-rib of the medicks, but its leaflets are long and narrow with toothed edges (Fig. 34). The flowers are usually a purplish blue, and the seed pod is coiled two or three times at the tip. The plant is a perennial, with a very strong, penetrating, main root, and the stems are produced from buds formed on top of its crown.

Lucerne is not commonly met with in leys or permanent pasture. It is best sown alone, or in conjunction with a small amount of cocksfoot or some other grass. Lucerne is not a good grazing plant because of the nature of the crown buds; it is best made into hay or cut for green fodder, for silage or for drying.

Birdsfoot Trefoil.

Birdsfoot trefoil can be identified by the leaf, which is made up of a short, stout stalk, bearing at its top three leaflets (a terminal one and two laterals) and at its base another pair of leaflets (Fig. 35). Its flower and seed head are unmistakable; the long, narrow, cylindrical pods, with their numerous seeds are arranged like the toes of a bird's foot on top of a long slender stalk.

As a rule this plant is found abundantly only in the poor types of pasture, particularly dry ones. It is a palatable herb, but hardly worth sowing. A similiar species, marsh, or greater birdsfoot trefoil, is found chiefly in wet situations, but seed is rarely, if ever, sown in seeds mixtures.

MAKING A NEW LEY

Our author begins with a consideration of the best methods of sowing the seeds, and discusses the pros and cons of using a nurse crop or sowing the seeds on bare ground. The various nurse crops available are described, after which the method of direct seeding without the use of a nurse crop is explained. Methods of distributing grass and clover seeds receive consideration, with special reference to the use of the ordinary corn drill, its advantages and disadvantages. A simple method of calibrating a corn drill for sowing small seeds is described in detail.

SOWING THE SEEDS.

Method of Sowing.

THE traditional method of sowing grass and clover seeds is under a nurse crop, usually a spring cereal like barley or oats. When rotations were short, and a clover ley occurred every four years, as in the famous Norfolk four-course rotation, it was imperative to sow the clover seeds in a cereal crop in order to save time. The primary purpose of most one-year leys is the production of hay, and none of our agricultural grasses and clovers, with the possible exception of Italian rye-grass, is capable of giving a good yield of hay in the season in which its seeds are sown. The plants need time in which to develop their roots and shoots, and this period of development can quite conveniently be spent in the shelter of a cereal crop.

Because of the success with which this system was practised for many years, the idea developed that grass and clover seeds demand a nurse crop if they are to establish themselves properly: that is to say, without protection of some sort, grass seeds will not grow satisfactorily. It is only recently that this idea has been seriously questioned from an agricultural point of view, though for a long time it has been customary to plant grass seeds for lawns, sports grounds and golf courses in the bare ground.

Nurse Crop.

The fact is, of course, that except in a few special circumstances, grass and clover seeds do better without a " nurse " crop than they do with it. The only " protection " that a cereal nurse crop can give to young, developing grass seedlings is shelter from occasional hot sunshine. This may, in some parts of the country, and in some seasons, be a valuable assistance. But against this protection must be placed the disadvantages brought about by the cutting off of sunlight, and the competition for plant food which cannot be avoided if a nurse crop is used. If the nurse crop be too rank, or if it be badly laid towards harvest, then the undersown seeds are bound to be seriously affected. The later in spring that the grass seeds are sown, the greater is the competition they have to meet from the cereal, particularly as regards sunlight, while there is also greater difficulty in obtaining a fine surface tilth on account of the increasing dryness and hardness of the soil, and a reluctance on the part of the farmer to damage the cereal by cultivations.

The realization of these handicaps imposed on newly sown leys through the use of a straw crop as a nurse has led to a movement in favour of planting ley seeds on bare ground, and encouraging the development of the resultant plants by almost immediate grazing. The technique of the method will be described later, after some account has been given of the older methods of ley establishment.

SOWING UNDER A NURSE CROP.

Method Under Grain.

1. *Using a Grain Crop.* Grass and clover seeds can be sown successfully in wheat, rye, barley, oats and beans, which are allowed to mature and ripen their grain. On the stiff clay lands which do not work at all easily in spring it is customary to sow wheat (or oats) early in the autumn. If the sowing is not done before the middle of October the crop may never get planted at all, because it is often impossible for tractors or horses to travel on the ground between the end of October and the end of March, so wet and " puddingy " does some of this land become. Consequently the young seedlings of grasses and clovers, from seeds sown in April, have to compete with wheat plants which are already five months old. They should be given the best possible conditions for development, and to ensure a good tilth in spring the tilth prepared in autumn must be on the cloddy side. The surface of the field, after the harrowing-in of the wheat, should remain studded with small clods about the size of a man's fist, and these clods should be left undisturbed until the last possible moment before the small seeds are sown. After the frosts and rains of winter, and the drying winds of March, these clods should break down into a fine mould at the touch of the harrows, thus providing an excellent seed bed. If the autumn tilth is left too fine the surface soil may pan down during winter so that much of the beneficial action of the frost is missed, and the production of a suitable mould may become an impossiblity in spring. The seeds should be planted as soon as the land is fit to work in spring. Early versus late planting, and broadcasting versus drilling, are subjects discussed towards the end of this section.

In the case of a spring sown cereal it should be possible to obtain a good tilth for the grass and clover seeds during the preparation of the ground for the barley and oats. But this tilth is often lost through postponing, for too long, the planting of the seeds. Where grass seeds are sown in May the land has had time to dry and harden, so that

soil conditions are by no means ideal for the small seeds. So far as suiting the grasses and clovers is concerned, the best time for planting is at the same time as the cereal. The tilth then is as good as it ever will be, and the grasses start level with the grain crop. The soil is moist, and germination should be rapid.

Simultaneous Planting.

Of course, the argument raised against sowing grass seeds at the same time as the nurse is that the grass and clover plants will grow too vigorously, and will be a nuisance at harvest. In a wet season this may be so, but over a very large part of the eastern side of the country, and also in the Midlands, the weather in spring is usually so dry, and the risk of failure through drought so considerable that the simultaneous, or almost simultaneous, planting of cereal and grass seeds is the better risk. Certainly this risk justified itself over wide areas during the seasons of the 1939–1945 war: but naturally in a district which has a consistently moist spring and early summer, the farmer can plant his grass seeds at almost any time and expect to make a success of the job. This chapter is not for such fortunate people: given ample moisture at the right time it is almost impossible to have a failure with seeds.

There is another point to consider here, and that is the check which a strong growing cereal will exert upon the under-sown seeds. If a full seeding of barley or oats be given, the establishment of grass seeds sown at the same time should not be affected: but the luxuriance of the grasses and clovers will be controlled by a full plant of the straw crop, and the young ley should not get out of hand and become a nuisance.

In Field Beans.

Very good takes of clovers and grasses can be obtained from seed planted in field beans. Beans are usually drilled in autumn, and it is desirable not to have a fine tilth. In spring the land can be harrowed without damaging the beans, the small seeds broadcast and covered with roller or harrows in much the same way as for winter wheat. It is desirable also not to have a very dense crop. There is a widespread opinion that though good takes of seeds can be obtained by planting in field beans, yet to plant clover seed on land which the *previous* year carried beans is courting failure. There seem some grounds for this belief in respect of red clover, which has at times been observed not to take readily the first season after beans. But how true it is in respect of clovers in general it is hard to say. Reliable observations on the point are scarce, and precise records would be useful.

Using Linseed.

2. Linseed has been used successfully as a nurse for seeds in various parts of the country. It lets the light down to the young clovers and grasses rather better than a cereal, and if the crop is sown fairly early it occupies the ground for only 3½–4 months before being harvested. Although early sowing is desirable, flax can be sown successfully rather later than the cereals, and for a man who is determined to have a nurse crop of some sort, this may be an advantage.

Using Green Crops.

3. *Using Crops Utilized in the Green State.* These green crops are much less of a handicap to the young seeds than are straw crops which ripen their grain in the normal way. They are removed much earlier, and the ill effects of their competition are consequently reduced.

One very commonly used plant is rape. It is sown with the grass and clover seeds at the rate of about 1½–2 lb. per acre. Rape germinates more rapidly than the grasses, and grows very quickly, producing broad leaves which shade the ground. So for leys sown in the summer, it may be useful in a dry time on account of this shade: but if continued for too long a time the shade may be positively deadly, smothering out the young seeds and entirely destroying them. The rape should be fed off by sheep from about the eighth to the tenth week, or earlier if growth is rapid. It is fatal to allow the rape to get too strong. If there is the least doubt about being able to graze the rape early enough, and with sufficient sheep, then the rape is best omitted.

The cereals can be used as temporary nurse crops: a bushel or so of oats or rye can be sown with the grass seeds, and grazed off with the young ley. One advantage claimed for this method is that grazing, and therefore treading, can begin sooner, since the cereal establishes itself earlier than the grasses. Under grazing conditions the cereal does not last for long, and consequently does not seriously compete with the ley.

A point here requires investigation. Does the use of say, wheat, as a very temporary nurse crop bitten off green, safeguard the grasses against wireworm damage? Wireworm damage to nurseless leys is often severe, but overlooked. Will wireworms attack young wheat seedlings in preference to grass and clover seedlings? Accurate data would be useful.

Temporary Nurse Crop.

On farms where the provision of the largest possible amount of fodder per acre is essential, it is possible to use oats and vetches, or rye and vetches, as a temporary nurse crop. The crop is mown at an early stage and carted off the field for silage. Naturally, if a thick crop of this sort is allowed to grow for too long a period, the development of the seeds will be seriously checked.

Italian rye-grass has been very much

recommended of recent years as a nurse crop for a ley; the usual quantity is 10 to 12 lb. per acre. There is no doubt that the inclusion of this weight of Italian rye-grass gives a tremendous bulk of greenstuff during the first season, and provides a very succulent pasture which covers the ground well. Italian rye-grass dies out in about 18 months, a period long enough for it to cause considerable crowding-out of the less aggressive species in the new ley. The second and third years of a ley sown down with 10 lb. per acre of Italian rye-grass are often much less successful than the first. Bare patches occur as the species dies away, and it takes time for the remaining plants to colonize these thin areas. Italian rye-grass is more likely to do harm through over-crowding than a cereal, because the life of a cereal when grazed is considerably shorter than that of the rye-grass. For long leys it seems undesirable to use as much as ten pounds of Italian rye-grass per acre: five pounds should be sufficient. My experience and opinion are that Italian rye-grass is often quite unnecessary and undesirable when sowing a ley on bare ground. A better result may be obtained by increasing slightly the quantity of perennial rye-grass, and applying a generous quantity of nitrogen—certainly not less than 1 cwt. per acre of "Nitro-Chalk" (a proprietary mixture of ammonium nitrate and calcium carbonate) or sulphate of ammonia—before sowing the seed.

Sowing Without a Nurse Crop.

Sowing a grass and clover seed mixture on bare ground without any of the conventional nurse crops is often called "direct seeding"; or if a turf field is ploughed up and immediately resown to a ley without a nurse crop, the process is called "direct re-seeding."

In its strictest sense the term "direct seeding without a nurse crop" would not apply if rape, rye or Italian rye-grass were used in giving the grass seeds a start. But it is not necessary to be so pedantic, and much of what has just been said under 3, p. 308, could be applied to these direct seedings and re-seedings.

The prime feature of most direct seedings is, however, its depasturing by stock at a very early stage of development. Certainly in the case of a direct seeding made in spring, its whole future depends upon the proper grazing of the young plants only a few weeks after the sowing of the seeds. In other words, direct seedings made in spring are essentially grazing leys for the first growing season. They must be grazed, and they must not be allowed to run up to hay during the year of sowing, although there is no objection to taking an early hay crop the second season.

Direct seedings may, of course, be made in late summer or early autumn. Sometimes the seeds are sown so late, or the subsequent weather may be so wet, that it is impossible to graze the young plants before the winter. They must, consequently, be left untouched until the soil becomes sufficiently dry and firm to permit of grazing without poaching the ground. The first grazing may, therefore, not take place until some time in spring, possibly six months after the sowing of the seed. Nevertheless, it is very desirable that this grazing at an early stage of *development* of the grasses and clovers should take place, as it does with a spring seeding.

This matter of early grazing of nurseless leys is dealt with more fully on p. 322, while the essential preliminary cultivations are described on p. 329.

When to Plant.

In the west of these islands, and in districts where the rainfall is heavy and spread throughout the whole year, grass and clover seeds need not be planted so early as in drier districts. In the eastern and south-eastern districts where the rainfall is about 25 inches per year or less, serious droughts occur in early spring and during the summer, and the principal limiting factor in the establishment of a ley is water. It is difficult for farmers living in, say, Devon and parts of Lancashire to understand why there is so much talk of the failure of seeds in the eastern counties. The drying winds of March, in some seasons continued right through the whole of May, so common in these counties and in some of the Midland counties, have to be experienced if the problem they present to the ley farmer is to be appreciated properly.

Dry District.

In a dry district it is essential for the young grasses and clovers to have well-developed roots before conditions become hot as well as dry. One way of encouraging this root development is to sow the seeds early. If the soil is in good condition, then the first weeks of March are not too early in many Midland and eastern districts. Seeds have been sown successfully for direct seeding as early as the last ten days of February. Germination is naturally slower than it is when the soil becomes warmer, but the young plants have moist soil in which to grow and develop their roots. Possibly over wide areas the sowing date to aim at would be the middle of March. Often there is a very dry period from about the middle of April to the middle of May, which is the traditional sowing time in many counties for grass and clover seeds. To ensure a good ley, seedlings should be well established at this date. In northern and exposed districts sowing may have to be delayed until the end of March.

August—September Sowings.

During the height of summer—June and July—it is usually inadvisable to attempt a sowing. But during August and early September another

chance of planting grasses and clovers presents itself. These months are often rainy, heavy dews are frequent, the soil is warm and rapid growth may be expected. For grasses conditions are excellent, and extremely good establishments can be made from August-September sowings. The snag comes with the clovers, for unless they have formed several permanent leaves and have developed a useful tap root before the frosts of winter, they are likely to perish. After the end of August every day's postponement of sowing reduces the clover's chance of survival.

In some districts there occurs quite regularly towards the end of July a break in the weather, with a rainy period extending over a week or more. Some farmers make a practice of sowing grass seeds at this time, as experience has shown that a successful take can usually be achieved. Knowledge of local weather conditions is, of course, very valuable, and is of far greater value in determining the optimum dates for sowing seeds than any general statement.

Methods of Sowing Seed.

Broadcast or Drilled.

Grass and clover seeds can be broadcast or drilled: broadcasting can be done by hand, by fiddle, by seed barrow, or by horse-drawn or tractor-drawn distributor. The term " drilling " is often applied to the operation performed by the last two machines, but for the purpose of this section the term " drilling " is understood to mean the placing of the seed below the surface of the soil by coulter or discs, as distinct from surface scattering or broadcasting.

When seeds are broadcast it is usual to roll the ground with a ring or Cambridge roller, which leaves the surface in tiny ridges and furrows. After the broadcasting, the seeds are covered either by light harrows or by rolling at right angles to the original direction. Sometimes the ridges are first harrowed down and then rolled. The depth of covering will depend very largely upon the fineness of the tilth and upon the weight of the harrows used: the heavier the harrows the deeper are the seeds likely to be buried. A very good cover can be obtained by using disc harrows, set quite or almost straight. On land recently ploughed from turf the use of discs in place of tined harrows largely obviates the nuisance of grass sods being brought to the surface during harrowing.

Some men are expert at broadcasting grass seeds between finger and thumb, but this is an art which is not easily acquired. A seed fiddle in competent hands gives a very good distribution, but unless great care is taken to walk true to the marks, quite wide misses can be made with serious after effects. It is very desirable to fiddle seeds in two directions to avoid such misses, particularly when sowing seeds for long leys. Some farmers fiddle their seeds from a tractor; they sit on a box facing backwards and drop the seed into harrows dragged along behind the tractor.

The seed barrow probably requires less skill than the fiddle, though it can be very laborious on uneven land: seed is pushed out of adjustable holes in the hopper by numerous circular brushes fixed in a revolving spindle actuated from the front wheel. The horse or tractor-drawn grass seed drill works on the same principle as the hand barrow, but is much wider. With very large tractor-drawn barrows the distribution of the seed at the two extremities of the hopper should be checked at intervals as there is sometimes a tendency for seed to work away from these.

If need be, seeds can be broadcast through an ordinary corn drill by removing the tubes or spouts, and allowing the seeds to drop direct on the surface of the soil.

A Recent Development.

A recent development is a wooden hopper the exact width of, and attached behind, a ring roller. A grooved spindle within the hopper is rotated by a star wheel running on the ground, thus pushing the seed out through a series of holes in the hopper; the rate of sowing is controlled by slides. The use of this implement cuts out one operation.

Some users have modified this implement by placing the roller *behind* the box. Their argument is that the land is usually left rolled down in the ordinary course of cultivation, and by having the roller behind the box the sowing of the seed and the covering are done in one operation—a considerable advantage if the weather is likely to break before the seed could be covered by a separate rolling.

The dry weather experienced in the spring of several recent years over considerable areas of the country has revived interest in the drilling of grass and clover seeds. Years ago this was a common practice, on the light soils of the Cotswolds for example, but for various reasons it declined. The chief object in drilling seeds is to place them at an even depth below the surface, in contact with moist soil. This leads to a more even germination, and to a very large degree prevents the " malting " of the seeds so common with broadcast grass and clovers due to a preliminary wetting followed by a period of drought. Frequently, drilled seeds germinate more rapidly than broadcast seeds, whilst the roots of the seedlings have an immediate advantage in that they are, from the first, deeply covered, and in constant contact with moist soil.

Depth.

Experience during the past few years has shown that grass and clover seeds can safely be planted much more deeply than is commonly supposed, both in light land and in stiff. On light sandy and chalky loams these seeds are frequently

mixed in the same hopper with barley or oats planted in spring and drilled at the normal depth for cereals, between 1½ and 2½ inches below the surface. Excellent takes have been obtained in this way. On stiffer land, of course, this practice might not be so successful, especially if wet weather set in immediately after drilling. Grasses and clovers have been established very satisfactorily on clay soils when drilled well over an inch deep in a good tilth. Moreover, it is quite possible to combine-drill these seeds with phosphatic and nitrogenous fertilizers. On Lias Clay, for example, good takes have been achieved in a very dry spring by combine-drilling with 3 cwt. superphosphate and 2 cwt. sulphate of ammonia per acre—drilling half the seeds and fertilizer one way, and the remainder at right angles to it. A mixture of slag and sulphate of ammonia should not be used through a combine-drill, for this reduces the germination of the seed with which it comes in contact.

Certain Drawbacks.

While drilling has definite advantages it has certain drawbacks. One is that the resultant plants are not evenly spaced over the surface of a field, but are confined to narrow rows several inches apart. One way of overcoming this is to drill half the seeds one way, and then cross the work with the spouts removed, thus broadcasting the remainder of the seed. There are a few specially constructed grass seed drills with coulters four inches apart or less, and with these a single drilling may be sufficient. Flax drills are very suitable for drilling ley seeds. When ordinary corn drills are used for drilling grass and clover seeds, the area of ground not covered should be reduced by drilling twice, the second stroke being performed either at right angles, or obliquely, to the first. When drilling on bare ground there is no objection to a third stroke to achieve even better distribution.

Another criticism made against drilling is that over-crowding of plants in the drills leads to undesirable competition between the grasses and the clovers to the detriment of the latter. It is also said that while grasses do very satisfactorily when sown deeply, the clovers do not do so well. These are points requiring further research, but they must be looked upon as of minor importance compared with the proved value of the drilling method for many conditions.

Late Summer: Broadcasting.

For late summer planting broadcasting is usually preferable to drilling: only a light covering of soil is required at this time of year.

Cereal drills of both coulter and disc pattern can be used. Where seeds are to be drilled into a standing cereal crop such as winter wheat, some farmers prefer to use a coulter drill as they consider this is likely to do less damage to the cereal than a disc drill. But disc drills have been used quite successfully for this purpose.

Mechanisms.

Both cup and force-feed mechanisms are suitable. When adjusting a cup-feed drill to sow a seeds mixture it is better to use the smaller cups run rather fast, than the larger cups run more slowly. This ensures a more regular distribution of seed in the rows. On banky ground it is difficult, with many cup-feed drills, to ensure an even rate ot sowing, because the seed is tilted in different directions and cannot be picked up in constant amounts by the cups.

Setting a Corn Drill to Sow Grass Seeds.

Adjustments.

Many corn drills will sow the usual type of seeds mixture without any special adjustments. They will sow from 12 lb. per acre (or even less) to upwards of 40 lb. per acre merely by adjusting the necessary cogs or gears. Some makers provide special attachments for sowing very small quantities indeed.

When using a drill for the first time, it is desirable to obtain some idea of how it will behave before going ahead with the planting. One method is to measure the quantity of seed which is delivered during the drilling of a measured area, say half an acre. Another method is to carry out the preliminary work under cover in the following way. The drill, or just the driving wheel, is raised from the ground upon an empty oil drum. The exact width from wheel centre to wheel centre at ground level is measured in feet, likewise the circumference of the driving wheel. The number of revolutions of the wheel made in one-tenth acre is then calculated from the formula:

$$\frac{9 \times 484}{\text{Width of drill in feet} \times \text{circumference of wheel in feet}}.$$

Seed is put into the drill, a sheet is spread out under the coulters or discs, the gear is applied, and the wheel is turned by hand the calculated number of times. The seed delivered on to the sheet is weighed, and this weight, multiplied by 10, gives the weight of seed drilled per acre.

An example should make this procedure quite clear. Width of drill, 7 feet, circumference of wheel, 13 feet:

$$\frac{9 \times 484}{7 \times 13} = 47$$

The figure 9 represents the number of square feet in a square yard, while 484 represents the number of square yards in one-tenth of an acre.

Therefore, 47 or 48 revolutions of the wheel take place in drilling 1/10 of an acre. At the

lowest possible setting of the drill, 1 lb. 6 oz. of a particular seeds mixture is the quantity delivered by turning the wheel 47 times. Multiplying by 10, we have the figure of approximately 14 lb. of seed delivered per acre: a very convenient amount in the case of the average sowing of about 30 lb. per acre, for it would permit the drilling of the seeds mixture in two directions, with a little to spare for accidents.

This procedure merely gives a guide: it is obvious that the jolting of the drill in actual planting will, in the case of cup drills, affect the rate of seeding. Further, it must be remembered that a mixture containing a high proportion of small seeds like timothy and white clover will pass through the drill more quickly than a mixture containing much Italian rye-grass. One therefore must not expect the drill always to sow all grass and clover seeds mixtures at the same rate.

If there is any doubt about the setting of the drill it is desirable to err on the side of too light a seeding. It is far better to have seed left over rather than find oneself short, because in drilling in two directions the rolling cannot begin until the whole field has been planted: a delay caused by shortage of seed may be serious if rain sets in and prevents the proper covering of the seed.

One point worth noting about drilling grass seeds with a disc drill is that the passage of the drill itself will reduce a knobbly soil to a much finer tilth. Although a fine tilth is most desirable, one need not hesitate to drill into a slightly lumpy surface with a disc drill, especially if it is intended to drill three times, as quite a number of farmers do for direct re-seeding.

All that is necessary after drilling is a good rolling, preferably with a ring roller. Harrowing is not essential, though it is frequently practised.

SEEDS MIXTURES

The important subject of Seeds Mixtures for grassland now engages the attention of the reader. The contrast between the prescriptions of thirty years ago and those of the present day is alluded to, and it is pointed out that there is a very remarkable reduction in the number of recommended species. The emphasis placed upon strain in herbage plants in modern prescriptions receives mention, after which specific recommendations for leys of different duration are made. For leys of three years and over the prescriptions are classified loosely into ultra-simple and simple mixtures according to the number of different species of plants utilized. Special mixtures for poultry purposes are suggested, and the famous Elliot or Clifton Park mixture is referred to. The section ends with some advice upon the purchase of grass and clover seeds.

A COMPARISON of the seeds mixtures for long leys now being offered by the leading seeds merchants, with those current say twenty to thirty years ago will reveal two, possibly three, striking differences.

Simplification of Mixtures.

The first difference is in the number of distinct species of plants included in the prescription. The older mixtures usually included well over a dozen different species, and sometimes as many as twenty; whereas today many prescriptions contain only six different species, and some are composed of two different plants only. This simplification of mixtures for long leys is due partly to the increased reliability of the seeds themselves, partly to the improvement of the herbage plants, and partly to the realization that a comparatively heavy seeding of a few species gives better results than an attempt to insure against a failure of "take" by including comparatively light seedlings of all sorts of plants. The results of competition amongst herbage plants—that is, the effect which one species may have upon its neighbours—are better understood than they were thirty years ago, and it is now realized that many of the minor species sparingly included in the very complex seeds mixtures of yesterday were doomed to extinction from the start. A ley with a comparatively few species is more manageable than a ley containing many species, for there are fewer peculiarities of growth to be taken into consideration.

Different Strains.

The second difference between the ley mixtures of yesterday and today lies in the increased importance which is given to different strains of the principal grasses and clovers.

Although a seeds mixture may consist solely, say, of perennial rye-grass, timothy and white clover, yet the recommendation may be to use no less than four different strains of the rye-grass, and at least two different strains of timothy and white clover. Reference has already been made to the characteristics of the different strains of the principal grasses and clover; an expert blending of these strains according to the needs of the farmer and the current price of the seeds can increase both production and profit.

Persistent White Clover.

The third point is that in modern prescriptions the inclusion of a persistent white clover is assumed to be an essential feature of all leys intended for more than two years. The pioneer work of Somerville and Gilchrist with wild white clover has borne abundant fruit and firmly established the value of this plant in long leys.

Very many different mixtures of seeds are used for the laying down of pastures and meadows in this country. Almost everybody who has taken an interest in grassland problems has his own views upon the compounding of seeds mixtures; indeed, there is such an inexhaustible variety of soil and climatic conditions, such a range of differences in the purposes for which the turf is required, and such a diversity of farmers and farming skill that it is not advisable to condemn any prescription out of hand.

At one time in the compounding of seeds mixtures a great deal of fuss was made of the nature of the soil on which the seeds were to be sown. But except in extreme cases, such as peats or excessively light land, soil considerations need not influence the choice of seeds to the same extent as the purpose of the ley, its duration and the rainfall it may expect to receive.

On the whole, grazing leys need a higher proportion of Italian rye-grass and white clover than leys intended chiefly for mowing.

The longer the ley, the smaller the proportion of broad red clover and Italian rye-grass, because both these plants are short lived.

In a dry climate, on a naturally dry soil, cocksfoot, crested dogs-tail and possibly Chewing's fescue, are likely to succeed better than perennial rye-grass.

In wet climates, trefoil does not do well, especially if the soil is at all short of lime.

Bearing in mind the characteristics of the principal herbage plants, as already set out, we can pass on to the consideration of seeds mixtures for different purposes.

ONE-YEAR LEYS.

Diversity of Prescriptions.

One-year leys scarcely come within the scope of this book for they form part of the arable land; there is such a wide diversity of prescriptions that it is impossible here to deal with them. It is worth noting, however, that Italian rye-grass has a tendency to smother out both red and white

clovers in a hay crop, as some experiments at Reaseheath, Cheshire, and others in Yorkshire have clearly demonstrated. If hay is the first consideration in a one-year ley, then Italian rye-grass should not be used; but if stubble and spring grazing are important, then three to five or more pounds of Italian rye-grass may be included.

A good general purpose one-year ley mixture is:—

14 lb. Perennial rye-grass.
3 lb. Broad red clover.
2 lb. Late flowering red clover.
1 lb. Alsike clover.

Some farmers, of course, rely entirely upon red clover, using about ten pounds per acre. If for some special reason (such as the isolation of pedigree rye-grass grown for seed) it is undesirable to use rye-grass, a timothy mixture may be employed:

10 lb. Timothy.
3 lb. Broad red clover.
2 lb. Late flowering red clover.

Woodhead gives examples of leys used on the Yorkshire Wolds, where it has been found that "the use of grass in leys adversely affects the following wheat crop."

5 lb. Broad red clover.
2 lb. Alsike clover.
2 lb. Alsike and Dutch clover.
6 lb. Dutch white clover.
4 lb. Trefoil.
1 lb. Ribgrass (Narrow-leaved plantain).

These examples are sufficient to show how very diverse are the mixtures in common use for one-year leys. It is not possible to be dogmatic about them, for soil, climate and the exact purpose for which the ley is needed differ so greatly.

Two-year Leys.

For leys which have to last for two harvest years, the short-lived broad red clover and Italian rye-grass are of limited value. It is better to rely upon late flowering red clover, perennial rye grass, timothy and cocksfoot, together with a vigorous type of white clover such as New Zealand certified Permanent Pasture, or mother seed, or S. 100. The inclusion of alsike clover, or on chalky soils, trefoil, is often practised as an insurance against the partial failure of the red clover.

A useful two-year mixture, primarily for hay, is that suggested by Stapledon and Hanley:

10–14 lb. Perennial rye-grass.
6–8 lb. Cocksfoot.
4–6 lb. Timothy.
4–6 lb. Late flowering red clover.

To provide some autumn and spring grazing, not more than 2–4 lb. Italian rye-grass can be added.

The similarity of this prescription to those now being advocated for 3-year leys, and "permanent" grass is very marked (see p. 315). The inclusion of S. 100 or New Zealand white clover in the above mixture brings it into the long ley class.

Three-year Leys and Longer.

Simple and Successful.

(*a*) *Ultra-simple mixtures.*

As a result of experience in the growing of pedigree grasses and clover for seed, there has been recently developed in Buckinghamshire, on the light chalky slopes of the Chilterns, a very simple and successful seeds mixture for a three-year ley. It consists, per acre, of:

6 lb. Perennial rye-grass (S. 23 or S. 101).
3-4 lb. White clover (S. 100).

The total seeding is only about ten pounds per acre, and the grass and clover seeds are mixed up with barley in the corn drill, and sown down the same spout. The success of this very simple mixture is due to the tillering capacity of the Aberystwyth rye-grass, and the vigorous habit of the clover. The heavy rate of seeding of the white clover is an essential feature of the procedure, for it gives the quick cover so essential to the formation of a weed-free sward.

A modification of this mixture, also developed from the seed growing technique, is:

15 lb. Perennial rye-grass (S. 23 or S. 101).
1 lb. White clover (S. 100).

Very fine pastures have been developed from this prescription in many parts of the country, but for success with such a small amount of white clover the soil must be in fertile state, and there must be adequate rainfall. On less fertile soils more white clover should be used. The New Zealand certified white clover can be used instead of S. 100, but it is very doubtful if good results would be obtained from the ordinary run of commercial perennial rye-grass.

Although these mixtures are primarily for grazing, yet they yield a surprising amount of excellent quality hay when mown. This is due to the vigorous growth of the white clover, which forms a dense bottom.

Moore gives the following ultra-simple prescription for a grazing ley in which the rye-grass is tremendously increased:

10 lb. Perennial rye-grass (commercial).
20 lb. " " (indigenous).
1 lb. White clover.
1 lb. Wild white clover.

This is intended for conditions where cocksfoot cannot be kept in check by grazing, and it is suggested that two pounds of rough-stalked meadow grass can be included if conditions favour this species.

An ultra-simple mixture of a totally different type consists of:—

3–5 lb. Cocksfoot.
15 lb. Lucerne.

This has been employed with conspicuous success on light dry "breckland" in parts of West Suffolk and in other places, where the rainfall is very low and where the usual type of mixture does not succeed.

(*b*) *Simple mixtures*

For general purposes it is customary to sow about 30–35 lb. of mixed seeds per acre, as this amount has been found to give reliable results over a great range of conditions. For fertile, easy-working land there is no need to sow such large quantities, especially if the better strains of grasses and clovers are used in the mixture.

A good example of a simple prescription for general purposes is the Cockle Park mixture. This was designed primarily for the north of the country, but it has given good yields of hay and excellent grazing in many counties. The usual prescription is:

16 lb. Perennial rye-grass.
10 lb. Cocksfoot.
4 lb. Timothy.
4 lb. Late flowering red clover.
1 lb. Trefoil.
1½ lb. Wild white clover.

This mixture obviously lends itself to all sorts of modifications, or elaborations, if the full range of commercial and indigenous strains of grasses and clovers is used. On soils which are not well supplied with lime it may be as well to omit the trefoil, and to include alsike clover, either in addition to, or in substitution for, the red clover.

Experience has shown that the perennial rye-grass and the cocksfoot can each be safely reduced about 4 lb. per acre for fertile conditions with consequent cheapening of the mixture. About 3–4 lb. of Italian rye-grass are sometimes added. Indeed, the modified Cockle Park mixture forms the basis of the recommendations which were made by the Ministry of Agriculture during the war in an attempt more or less to standardize seeds mixture and so enable them to be made up in bulk. Two of these recommendations are as follows:

Timothy mixture

4 lb. Italian rye-grass.
16 lb. Perennial rye-grass.
8 lb. Timothy.
3 lb. Late flowering red clover.
1 lb. S. 100, or New Zealand white clover.
½ lb. English wild white clover.

Cocksfoot mixture

4 lb. Italian rye-grass.
16 lb. Perennial rye-grass.
6 lb. Cocksfoot.
3 lb. Late flowering red clover.
1 lb. S. 100, or New Zealand white clover.
½ lb. English wild white clover.

(In both these prescriptions the use of a proportion of indigenous strains is recommended.)

The chief difference between the two-year and the longer ley mixtures is to be found in the use of different strains of the various plants included. In a two-year ley probably all plants would be "commercial," but for the longer ley a blend of commercial and indigenous (or leafy) strains would give a longer period of growth. For example, the perennial rye-grass might well be made up of 4 lb. each of Irish, New Zealand Certified Permanent Pasture, S. 23 and S. 101. The cocksfoot should include 3 lb. Akaroa and 3 lb. S. 26 or S. 143, and so on. On soils of poor fertility the inclusion of crested dogstail, rough-stalked meadow grass and Chewing's fescue may be desirable. Stapledon and Hanley suggest, for grazing purposes on poor dry soils in low rainfall areas:

12–14 lb. Perennial rye-grass.
6–8 lb. Chewing's fescue.
2–3 Crested dogstail.
2–4 lb. Wild white clover.

This mixture would probably be improved by using 2 lb. New Zealand white clover and 1 lb. wild white clover.

Land to be seeded down for poultry purposes requires a seeds mixture rather different from the normal. Poultry soon destroy red clover for example, while tall-growing grasses such as cocksfoot and Italian rye-grass are undesirable since they rapidly become coarse and unsightly and interfere with the birds' exercise. For general poultry purposes a mixture on the following lines might be used:

16 lb. Indigenous perennial rye-grass.
8 lb. Smooth-stalked meadow grass.
3 lb. Creeping bent.
3 lb. Chewing's fescue.
¼ lb. Wild white clover.

THE ELLIOT OR CLIFTON PARK MIXTURE.

R. H. Elliot.

Some mention must be made of the seed mixtures used by R. H. Elliot in the improvement of his estate at Clifton Park, Roxburghshire,

between 1887 and 1910, if only because of the recent revival of interest in deep-rooting pasture plants. The chief features of the Elliot mixture were the entire omission of perennial rye-grass and the inclusion of deep-rooting herbs such as chicory, yarrow, burnet, kidney vetch and rib-grass (narrow-leaved plantain). The "New Bankfield" mixture, for example, was made up as follows, and can be regarded as typical:—

3 lb. Italian rye-grass.
14 lb. Cocksfoot.
6 lb. Tall oat grass.
½ lb. Golden oat grass.
3 lb. Tall fescue.
3 lb. Meadow fescue.
1 lb. Rough-stalked meadow grass.
3 lb. Chicory.
8 lb. Burnet.
½ lb. Yarrow.
2½ lb. Kidney vetch.
1 lb. Alsike clover.
2 lb. Late-flowering red clover.
1½ lb. Dutch white clover.

The idea of using the "herbs" was to break up the subsoil by means of their powerful, deep roots, and at the same time to enrich the poor, stony land forming most of the Clifton estate. Moreover, these deep-rooting plants were able to persist under the conditions of drought common to the district. The leys established from these seedings were not intended to be permanent, but were part of a system of ley farming where the grass endured for four years or longer.

Great success was achieved by Elliot in improving his impoverished farms but the system has never become popular. This, of course, does not necessarily mean that it is unsound. It is necessary to note that the work was carried out before the value of wild white clover and its interaction with basic slag were properly appreciated.

Choosing a Seeds Mixture.

Careful Choice.

A great deal has been said and written on this subject, yet it is remarkable how few farmers give the matter much real thought. Those farmers who do think about the subject are usually conspicuously successful with their leys, although they probably spend no more per acre on their seeds than their not-so-successful neighbours. The fact is that few farmers study their grasses and clovers with anything like the care they devote to other crops and in buying their small seeds they put themselves entirely in the hands of their suppliers. This is very understandable, because few farmers have had occasion in normal times to put down land to a long ley; yet no matter how trustworthy a merchant may be—and the reputation of seed suppliers in the country is deservedly high—he obviously cannot have the detailed knowledge of the farm which the farmer possesses nor of the precise needs which the ley is expected to serve. The merchant is a business man and he naturally wishes to do good business; and a relatively expensive seeds mixture is usually better business from his point of view than a less costly mixture, though it may serve the farmer's purpose no better than the cheaper one. This is not to suggest that all merchants habitually, and with forethought, force expensive mixtures upon their clients, but in this imperfect world it is up to each man to protect his own interests. Consequently, for the farmer who has not got sufficient knowledge of plants and leys to make his own choice of seeds, the guiding rule is to deal with a firm of repute and buy "the best." He will not be let down but he may have to pay a bit extra for this security. The man with the necessary knowledge should also deal with a firm of repute, but there is no need for him to buy "the best," if by this is meant the highest priced seeds. He may find a mixture at 60/- per acre equally as satisfactory for his circumstances as "the best" at 105/- per acre.

Suitability.

The knowledgeable man appreciates the fact that high prices are no guarantee of suitability: the price of seeds is determined primarily by supply and demand and not by their potential value to the farmer. Another point is that the bulk of the seed of grasses and clovers used in this country is imported and distributed by wholesalers for the retail firms, so that exactly the same class of seed may appear in different catalogues at different prices and with different descriptions.

The certain method of buying disappointment and loss is, of course, to buy "cheap" seeds from an unknown dealer.

MANURING FOR GOOD GRASS

This section begins by ruling that grasses must be treated like any other plants if maximum production is to be achieved. The crying necessity for lime in many districts is forcibly stated, and some account is provided of the different kinds of lime available and the best ways of using them. Phosphates are regarded as being quite as essential as lime, and the best forms of phosphatic fertilizer are described, after which the profitability of nitrogen is discussed, together with some account of the common nitrogenous manures. The special needs of the hay crop now need attention, and the virtues and demerits of farmyard manure as a fertilizer for mowing grass are looked into, following which a recommendation for a regular manurial programme for hay ground is made. Finally, the less complex problem of manuring grazing pastures is dealt with.

Proper Manurial Treatment.

SOME farmers still think that grasses are different from other farm plants as regards their need for manures. While they fertilize roots and cereals as a matter of course, they expect "grass" to look after itself, which it usually does very badly. Grasses and clovers are, of course, crops just as much as any other plant, and they respond very well to proper manurial treatment. Just as it is impossible to obtain satisfactory crops of cereals on land deficient in the usual fertilizing elements, so it is impossible to establish and maintain a good ley on deficient soil.

Lime, phosphate and nitrogen are the chief substances which have to be added to soils in order to make them fully productive of grasses and clovers. Lack of potash is less frequently the cause of a poor ley.

ADVANTAGE OF ANALYSIS.

Although there was a considerable increase in the amount of lime used on farm land from 1923 onwards, due to the realization that without lime sugar beet is liable to be a complete failure, yet only quite recently has it been recognized that, of grassland plants, clovers in particular are very sensitive to lime shortage. Red clover is especially liable to fail in an acid, or lime-deficient soil. Morley Davies, as the result of numerous experiments in the West Midlands, reports that red clover will fail if the acidity reaches pH5·5* and white clover pH4·5. Rye-grasses fail at pH4·3. Consequently, if there is any doubt about the matter, a field which it is proposed to seed down to a ley should be analyzed for lime, phosphate and potash. The nitrogen present in the soil is usually not estimated; it is assumed that the nitrogen will in any case be deficient, and practical experience has proved this assumption to be generally accurate.

Lime.

If lime is needed it should be applied to the soil before the seeds are sown. The best time to apply lime to a direct re-seeding is after ploughing, but before the final harrowings, so that it can be well worked into the ground. On very acid soils, such as those found close to the industrial districts of the North Midlands, Wells and others have found it desirable to plough in lime with the turf, and then add more on top of the furrow to be worked in by surface cultivation. They are inclined to add twice the "lime requirement" as shown by ordinary analysis because of the very acid subsoil.

Form of Lime.

It does not matter much what kind of lime is used, so long as the required amount of calcium oxide (*Chemical formula* CaO), as shown by analysis is applied. Although lump, or cob lime, is the purest form of lime it is not advisable to use this in the traditional manner, that is, placing it out evenly in small heaps over the field and allowing it to slake down before final distribution. It is wasteful of time, labour and lime. It is probably more economical to tip the lime into a large heap and let it slake down before distributing it. Caustic lime can be bought as ground burnt lime in bags, and put through a manure distributor. The chief advantage of burnt, or caustic lime, is that it contains more calcium oxide than other forms, with the consequent saving in transport charges and time taken in distribution. It has several disadvantages, the chief of which are liability to burst its containers, and the unpleasantness of handling.

Ground limestone, or ground carbonate of lime, has to be applied at almost twice the rate of burnt lime to bring about the same result; but it is more pleasant to handle, and it stores in better condition. The net cost is almost the same as that of burnt lime. Hydrated lime has no special advantages over ground limestone on a farm scale, and is more expensive. In some areas chalk can be obtained on reasonable terms. Waste limes, such as sugar beet sludge lime, are not always suitable for application to arable land immediately before planting grass seeds. They are immensely valuable sources of lime—and sugar beet waste lime contains in addition some fertilizing qualities —but because of the moisture they contain they are more easily applied to a stubble some time before the ley is due to be planted. Where the ley is to be planted in a cereal nurse crop, the lime should be applied before the cereal is planted.

Whatever form of lime is used, it is very

* pH is an acidity scale from 0 to 14 on which neutrality is represented by pH7; the smaller the figure the greater the acidity. Sugar beet is liable to fail at an acidity represented by pH5·3.

desirable to get it well worked into the surface soil and mixed up with it before sowing the seeds.

Phosphate.

Phosphate is quite essential for a good take of clovers. It has been repeatedly and conclusively shown in demonstrations and experiments all over the country that a good establishment of clovers is impossible in a phosphate-deficient soil. The evidence regarding the grasses is not so spectacular, but here again phosphate adds tremendously to the certainty of a "take." Therefore the soil must be well supplied with phosphate before the seeds are sown. If a soil is acid as well as deficient in phosphate, it is necessary first of all to lime the land in order to obtain the best results from the phosphate to be added later.

The available phosphatic manures are basic slag, bone meal, steamed bone flour, ground mineral phosphate, superphosphate, triple superphosphate, and ammonium phosphate.

The last two of these are very concentrated. Ammonium phosphate is extremely soluble and quick acting, and contains 48 per cent phosphoric acid, plus 11 per cent of nitrogen. Triple superphosphate contains about 40 per cent phosphoric acid, also in a readily available form. For very short leys, or for establishing a long ley, ammonium phosphate and triple superphosphate are very useful, but their effect appears to be comparatively short lived. A ley so fertilized may need more phosphate the next season if it is to make continued progress. This is a most important point; failure to renew the phosphate leads to failure of the ley.

Ammonium phosphate at the rate of approximately two cwt. per acre (*i.e.*, one cwt. per acre sown in each direction) has been extensively used by some War Agricultural Executive Committees in drilling grass and clover seeds for direct re-seeding.

Ground mineral phosphate consists of the phosphatic rock ground up very fine indeed; it is not treated with acid like superphosphate. Experience shows that only in the wetter districts of these islands is ground mineral phosphate so useful and reliable as the other phosphatic fertilizers.

Ordinary superphosphate, with 16–18 per cent phosphoric acid, applied at about three to four cwt. per acre may be regarded as a suitable preliminary dressing for a ley.

Steamed bone flour is a very valuable organic phosphate containing 25–32 per cent phosphoric acid. It is usually rather expensive compared with other phosphates, and should be reserved for more immediately profitable arable crops.

Basic slag is available in various grades, with phosphoric acid (P_2O_5) contents ranging from 9 to 20 per cent. Slags vary not only in fineness of grinding, but also in their solubility in citric acid. The high phosphate slags, when obtainable, are to be preferred to the low grade slags (9 per cent phosphoric acid), and high soluble slags are more reliable than low soluble slags in most circumstances. Slag is probably the best form of phosphate to apply in preparation for a long ley on most soils. The lime which it contains is worth consideration on soils naturally short of this material, but the use of slag is no excuse for not liming an acid soil. Rather is it highly desirable to lime an acid soil before applying a phosphatic fertilizer, in order to prevent the phosphoric acid from becoming chemically changed by the acid conditions and rendered unavailable to plants.

During Establishment.

During the time that a ley is establishing itself the grasses and clovers must be looked upon as an arable crop; from investigations conducted during war-time one is led to question the economics of applying slag in extremely generous amounts before planting the ley and then leaving the ley without further application for three to four years. Before the war a dressing of ten to fifteen cwt. per acre of slag to grassland would not be considered particularly extravagant. But that was for permanent grass, on which light applications of slag were found, as a rule, to have only small effects. On young, developing grasses and clovers, relatively small doses of slag can have much more influence, and it may be better to apply, say, seven cwt. per acre of slag to a ley before planting, and another seven cwt. in eighteen months time, rather than fifteen cwt. before planting, followed by a slag-less interval of three to four years. More precise information on this point is badly needed for all soil types, since what applies to one soil may not be true of another type.

An advantage possessed by slag over its concentrated competitors is that it can be more evenly distributed over a field. This may be of some importance if only unskilled labour is available.

It is not essential to apply slag a long time before the seeds are sown. On tillage ground (and a new ley is a tillage crop for at least the first year of its life) slag acts only slightly less rapidly than superphosphate. This has long been recognized in the case of turnips, and it is true also of spring sown cereals and herbage plants.

Nitrogen.

Nitrogen, in the form of sulphate of ammonia or "Nitro-Chalk," gives very good dividends when applied to young leys. To get the best results from a direct re-seeding, some nitrogen should be given with the phosphate before planting, particularly if the seeds are sown very

early, and more particularly still if the re-seeding is on the top of a recently ploughed-out turf, since the preliminary rotting of the turf itself locks up some of the nitrogen. The value of some readily available nitrogen to young grass seedlings is very great, for it increases their rate of growth in a remarkable manner. A minimum dressing should be one hundredweight per acre, and on stiff clays this can be increased with confidence to a full two hundredweight sulphate of ammonia or "Nitro-Chalk." What the profitable maximum amount of nitrogen to apply may be, it is hard to say; but increased response in growth has been observed on a clay soil for each hundredweight of sulphate of ammonia applied up to a total quantity of four to five hundredweight per acre. Here again much more experimental evidence is needed.

Principal Sources.

Sulphate of ammonia and "Nitro-Chalk" are mentioned here because they are the principal sources of nitrogen. These two materials may be looked upon as roughly interchangeable; sulphate of ammonia contains 5 per cent more nitrogen than "Nitro-Chalk," and "Nitro-Chalk" contains about 50 per cent of lime, which is absent from sulphate of ammonia. These two fertilizers act upon plants in slightly different ways, but these differences, so far as they are understood at present, appear not to be of importance in ley establishments.

If ammonium phosphate is used as the source of phosphate then it is not necessary to add further nitrogen to the soil. Nitrate of soda, which has 15–16 per cent of nitrogen, can also be used as a source of nitrogen, and on potash-deficient soils, nitrate of potash. These last two substances may cause trouble if made up into a compound fertilizer, because the mixture goes hard if stored for any length of time.

On potash-deficient land it is desirable to apply some cheap form of potash, such as Kainit, or low-grade potash salts.

The application of nitrogen to a ley planted in a straw crop is a matter requiring thought. Many spring-sown cereals would benefit from a small amount of a nitrogenous fertilizer at planting time—say, the equivalent of half a hundredweight per acre of sulphate of ammonia; winter wheat, too, may benefit from a light top-dressing. But an excess of nitrogen may do much harm; it may, according to its time of application, stimulate too much either the cereal or the grass and clover. If the cereal grows too rank the seeds may be partially smothered, either by excessive growth or because of lodging, or both. If the season is wet the "seeds" may grow too vigorously and be a great nuisance at harvest. Consequently, nitrogen should be sparingly used when a cereal is undersown. In any case it is inadvisable to top-dress with nitrogen an undersown cereal just as the clover is showing its seed leaves above ground; sulphate of ammonia is liable to scorch and destroy the seedlings.

Applying Fertilizers.

The usual method of applying fertilizers to land intended for a ley is broadcasting by machine or by hand; properly done, this gives an even distribution. It is, however, possible to use the combined seed and fertilizer drill with perfect safety if certain precautions are taken. Possibly the most important is to make certain that basic slag and sulphate of ammonia are not mixed and placed in the fertilizer box. Not only is this objectionable on purely chemical grounds, since their interaction sets free some of the nitrogen in the sulphate of ammonia, but in addition the germination of grass and clover seeds is considerably reduced when such a mixture is placed alongside them.

Superphosphate and sulphate of ammonia, or superphosphate and "Nitro-Chalk" have no such deleterious action. As much as three hundredweight per acre of ordinary superphosphate and two hundredweight sulphate of ammonia have been successfully combine drilled (in two directions, of course) with grass and clover seeds; for general purposes these quantities might be regarded as maximum amounts, which could quite well be reduced by one-third, especially if there is much clover in the seeds mixture. The combine-drilling of ammonium phosphate for ley establishment has already been mentioned, and this is a very convenient way of applying both nitrogen and phosphoric acid. Other compound fertilizers can, of course, be used through the combine-drill.

MANURING ESTABLISHED GRASSLAND FOR HAY.

A heavy hay crop removes from the soil a considerable quantity of plant food; unless some return is made the weight and quality of subsequent crops, as well as the fertility of the soil, will diminish. Some soils are much more able to produce without any manuring a succession of useful crops of hay than others. Deep alluvial soils, particularly if they are regularly subject to standing floods, may continue almost indefinitely to yield hay crops of 20–30 cwt. per acre. At the other end of the scale are poor, heavy clays, and thin dry soils, where the natural hay yield is probably about ten cwt. per acre for an average season.

Suitable Manuring.

A great deal can be done to improve the yield and quality of hay by suitable manuring. The improvement will be greatest, of course, on those soils which support inferior turf. There are some mowing fields from which little economic return can be brought about by manuring—it just does not pay to spend money upon manures for certain meadows, however interesting the results may be.

These fields may not be very numerous, but it is as well not to make a fetish of manuring for manuring's sake.

Lack of Lime.

In many districts the limiting factor in hay production is lack of lime, and if a farmer is in any doubt about this he should consult his County Agricultural Officer or Provincial Advisory Chemist. An abundance of common sorrel and sheep's sorrel, ragwort and bracken, is a pointer to lime shortage, as is usually a high proportion of the small fescue grasses. Light sandy and gravelly soils are naturally short of lime, but some strong, heavy soils, such as those of the Coal Measure formation, are also lime-deficient. The very acid soils of the Millstone Grit in Yorkshire, Derbyshire and elsewhere, whose herbage has to stand up to the additional handicap of a very acid atmosphere from the industries of the area, respond very well indeed to applications of lime. Conversely, the heavy clays of the Lower Lias formations, so wide spread in the Midlands, actually contain free lime, and cannot be expected to respond to liming. To spend money on lime for such soils is unnecessary and wasteful.

Dung.

Frequently the only fertilizer applied to meadow land cut for hay is farmyard manure; although dung is usually regarded as a complete manure its composition is very variable, and it cannot be regarded as completely satisfactory for the production of hay. Before the war, when imported feeding stuffs were very cheap and were used in enormous quantities, the farmyard manure produced on dairy and pig farms was of high quality. Applied in large dressings every year to grassland, as it was at one time in Cheshire, Lancashire, and other milk-producing counties, it lowered the quality of the hay and encouraged strong growing weeds such as hog-weed and sorrel, and weed grasses like Yorkshire fog and brome grass. On all-grass farms, in fact, farmyard manure sometimes became a nuisance, to be got rid of in the best manner possible. Both farmyard manure and liquid manure tend to encourage a coarse growth of grasses and a weedy herbage.

The best way of using farmyard manure on grassland is probably to make an application of about 10–15 loads per acre every three years, and to use fertilizers and, if necessary, lime during the intervening years. In this way the special virtues of the dung, namely its slow yielding up of the organic residues, its humus-forming and its water-holding properties are utilized without any of the corresponding disadvantages.

Phosphate Desirable.

Phosphatic fertilizers are usually necessary if the quality of the hay is to be maintained. Phosphate is desirable because of its influence upon root development and because of the way in which it encourages clovers. The yield per acre of hay is not strikingly increased by phosphate alone, except upon those soils which are naturally very deficient in phosphate; such soils usually yield very poor crops in the un-fertilized state (about 7–10 cwt. per acre) and they respond very remarkably to applications of phosphate because of the encouragement given to wild white clover and wild red clover.

Potash.

On some soils potash has to be added if a good response is to be obtained from phosphate. In any case, mowing land should receive potash because so much of this material is taken away in the hay; under grazing conditions much of the potash in the herbage is returned to the soil in the droppings of the grazing animals.

Nitrogen.

Nitrogen in some form or another is, of course, essential for the vegetative growth of plants, and bumper crops of hay cannot be obtained if the ground is starved of nitrogen. Provided the soil is properly supplied with lime and phosphate (and in some cases potash as well), quite large doses of nitrogen can be given with profit, and without damage to the sward. On the other hand, of course, the indiscriminate use of nitrogen on phosphate-and-lime-starved soils, will easily worsen the condition of the turf. Lack of attention to the phosphate and lime condition of grassland soils by users of nitrogen is one of the chief reasons why nitrogen has acquired such a bad name in certain districts.

Annual Dressing.

Assuming, then, that no dung is available for the mowing ground, a sensible and economic annual dressing per acre for the hay crop on light to medium land would be:—

2–3 cwt. superphosphate.
1–1½ cwt. Kainit, or low grade potash salts.
1–1½ cwt. sulphate of ammonia, nitrate of soda, or " Nitro-Chalk."

To avoid the troubles which often arise when a fertilizer containing potash has to be mixed by the farmer, recourse may be made to one of the proprietary compound fertilizers containing phosphates, potash and nitrogen. Some of these, especially those compounded from triple superphosphate or ammonium phosphate, are more concentrated than mixtures made up by the farmer himself from the ingredients mentioned. In the using of these compounds recommended dressings per acre should be followed until, by experience, the farmer discovers what amount suits his soil and conditions best.

On stiff clay land it is sometimes recommended to use generous dressings of basic slag applied in the autumn, with spring top dressings of sulphate of ammonia or "Nitro-Chalk." This often gives good results, but we badly need more experimental work on the effect of manuring heavy land for hay with the newer phosphatic fertilizers, such as triple superphosphate and ammonium phosphate.

Type of Farming.

It is very unwise to dogmatize about the most profitable way of fertilizing meadow land, because so much depends upon the type of farming. On a farm which is largely arable the most profitable way of using dung is upon the plough land; on a mainly grass farm, of course, if the fullest use is to be made of the dung a very large quantity will have to go on the grassland. In the first case it is clear that only at wide intervals can the mowing land get a dressing of farm-yard manure; in the second instance, the farmer must so arrange matters that no one field gets so much dung so often that the quality of his hay will suffer. By balancing up every second or third year with phosphates applied as the sole dressing this deterioration can be avoided.

Hanley has suggested the following two methods of rotational manuring for meadow hay, depending on the amount of dung available:

System 1.

1st year—farmyard manure.
2nd year—phosphatic fertilizer.
3rd year—nothing, or 1 cwt. nitrogenous fertilizer.

System 2.

1st year—farmyard manure.
2nd year—phosphatic fertilizer.
3rd year—farmyard manure.
4th year—nitrogenous fertilizer.

Grazing the Aftermath

To get the best results from any system of manuring meadow land which is frequently cut for hay it is necessary to graze the aftermath as soon as the hay has been removed. Grazed immediately, the grasses and clovers are able to grow to the grazing animal, whereas if the grazing is postponed until late in the season these plants do not have the same chance of development. To graze down the stubble of a hay crop is to encourage the dwarfer plants which have been starved of light by the more typically hay species during a large part of the growing season. Unless these dwarf species, in particular the white clover, are allowed to develop, the sward tends to become open, and the hay loses its fine-quality bottom growth and becomes relatively coarse.

Manuring Established Grazing Land.

A Simpler Matter.

This is a simpler matter than manuring for hay since the grazing animal returns in its dung most of the nitrogen it obtains in its food, much of the potash, and a smaller proportion of the phosphate and lime. Consequently, the manuring of established grazing land is chiefly a matter of maintaining the lime and phosphate status, renewing the quantities of these two materials taken away from the land as bone and milk.

Importance of Phosphate and Lime.

As an indication of the importance of phosphate and lime, in every gallon of milk there is the equivalent of ¼ ounce of lime (CaO), and ⅓ ounce phosphoric acid (P_2O_5). For every pound of meat produced by an animal approximately the same quantities of lime and phosphate are required. These nutrients can only be supplied through the food, so that an animal supporting itself entirely by grazing does make considerable demands upon the soil.

Basic slag is the most widely used phosphatic manure for grazing land, largely because of its relatively lasting effect compared with superphosphate, and the phenomenal—and widely publicised—results which it has given in encouraging wild white clover on poor clays deficient in phosphate, but well, or moderately well, supplied with lime.

Slag.

Light dressings of slag are frequently unsuccessful in improving pasture land, for it appears that the land needs to become—as it were—saturated with phosphate before the surplus becomes available to the herbage. On some clays, at least twelve to fifteen cwt. per acre, and occasionally as much as a ton, of a medium grade slag (twelve to fourteen per cent P_2O_5) have to be applied before any improvement is noticeable. Once the initial improvement has been obtained, considerable smaller dressings at intervals of three to four years may be sufficient to maintain quality and productivity.

Phosphates will not act properly on a grazing turf if the soil is short of lime or potash. If slag fails to bring about an improvement on grazing land a soil analysis is desirable to find out the limiting factor.

MANAGEMENT OF GRASSLAND

This is perhaps the most important section of the whole book, for without good management no grassland can be good for long. We start off with the management of a young sward from seed sown on bare ground in spring, considering in turn the class of stock to use, how long to turn them in, and when not to graze. Some weeds of direct seedings and how they may be dealt with are next described. The treatment of a ley after the removal of the nurse crop is the next point, after which comes a consideration of the way in which to treat established turf. Some wise words of Sir George Stapledon are quoted, especially on the subject of palatability. The different habits of sheep, cattle and horses as they affect grasses and clovers, and the virtues of mixed grazing are then explained. The control of the botanical structure of grassland by grazing animals is referred to. Management for " early-bite " in spring, suggestions for rotational management, and cultivations are other subjects dealt with.

Management of a Young Nurseless Sward.

Where seeds are sown in spring upon bare ground without a nurse crop of any sort (except possibly Italian rye-grass) it is desirable to graze the herbage as soon as possible. This will usually be from eight to twelve weeks after seeding, depending upon date of sowing and the weather conditions. It is, of course, quite impracticable to take hay from such a ley during the seeding year; such a procedure would ruin the sward before it developed. But if for any reason it becomes impossible to graze the young herbage, mowing for silage or for drying purposes, or just mowing over whilst only six to twelve inches high, would be permissible—or rather essential—to encourage the young plants to stool out.

Proper Grazing.

Proper grazing in the early stages of a nurseless ley has a great and beneficial influence upon the development of the sward. In the first place the treading of the stock provides the consolidation which is so essential for the proper growth of grass roots, and which minimizes the ill effects of drought. Such consolidation cannot effectively be initiated by rolling, desirable as rolling may be in many circumstances. Secondly, the biting off of the tips of grasses and erect clovers stimulates the formation of side shoots close to the ground, and this leads to a more rapid covering of the soil through the development of compact, bushy plants. Plants which are allowed to grow too tall before being topped off are relatively spindly and weak.

Grazers.

It does not matter very much whether sheep or cattle are turned in first. At one time many farmers thought sheep were the only possible first grazers, but this is definitely not the case, for very good leys have been established by direct methods without using any sheep at all. Whichever class of stock is used it is desirable not to graze too hard the first time. It is better to turn in a great many animals to bite off the herbage in a short time and then remove them rather than to let in so few animals that they never really master the growing crop. Under-grazing in the early days is fatal to the best results, but it is equally undesirable to allow sheep to graze the immature plants so close to the ground that they can recover only with a great effort.

On and Off System.

A quick graze over with many animals, a short period in which to recover, more grazing, another rest period, and so on. That is what is meant by " the on-and-off " system of grazing which works so successfully on these new grazing leys.

Digestive Disturbances.

The accusation is frequently made that the new grazing leys scour cattle, particularly young cattle, very badly. This is scarcely a general complaint though scouring and " blowing " to some degree may be frequently experienced, particularly if a heavy seeding of white clover has been used. It is desirable to accustom stock gradually to a young ley in which the proportion of white and red clover is high and which is in rather an advanced condition before being grazed for the first time. Some graziers claim that if loose straw is placed round the hedges of a young, clovery ley, the stock will help themselves to it and thus prevent serious digestive distubances.

Difficulties.

It sometimes happens that a direct re-seeding, especially if drilled very early in the year, establishes itself very well indeed, yet the individual plants have very insecure roothold because of the extreme dryness of the topsoil. This has happened in several places in the Midlands during the unusually dry springs experienced of recent years. On the stiffer soils the dry conditions have made it impossible to obtain a really fine tilth, with the result that innumerable tiny lumps ranging in size from a golf ball to a marble are left on the surface. These defy all attempts at breaking them down, they soon dry out, and in consequence it becomes impossible to consolidate the soil properly. Grasses planted early find enough moisture to keep them going quite well, but owing to the loose soil they pull out very easily, even when several inches long and tillering strongly.

The farmer is awkwardly placed when these conditions occur. He knows that he ought to graze the ley early, yet he is afraid that the

grazing animals will pull up and destroy many of the tenderly rooted plants. If the drought continues, as it may do for weeks, what is he to do? Rolling is useless, for the small, dry surface clods behave like dry ashes, and shift without binding together.

In such a case sheep are useful, for they do not tear up the plants in the way that cattle uproot them with every mouthful. If sheep are not available, and the grasses are obviously growing away from stock, a cut for silage or drying may be taken. Rather than allow the herbage to overgrow, a mow-over, with the cut material merely falling back into the ground, may prevent damage until such time as a shower of rain moistens the top soil and enables either the roller to be used or cattle to be turned in.

If it is essential that cattle should use the ley, then it is desirable, in the case of a large area, to divide it up in some way so as to concentrate the stock and thus to ensure that as many as possible of the uprooted plants shall be trodden back into the ground and receive the benefit of the moisture from the urine and manure.

Thistles.

One of the most serious troubles in a directly re-seeded ley is thistles. Both the spear thistle and the creeping thistle may crop up in tremendous numbers during the first few months of the ley's existence, and they may be so plentiful as to interfere very much with the grazing.

The spear thistle is possibly the more difficult plant to deal with. It is a biennial, and during the first season forms the characteristic rosette of spiny leaves which sits down tight on the ground. It may or may not throw up a stem the first year. If it does, and the stem is cut with a scythe or mowing machine, two or three other stems are stimulated into growth, and the last stage of the weed is worse than if it had not been cut at all. Really the only effective way of eradicating the spear thistle is to spud or hoe it up while in the rosette stage—but this is usually impossible because of labour difficulties. In two seasons, of course, the plant seeds, exhausts itself and dies; it will be no more trouble during the life of the ley but it leaves a legacy of living seeds to plague the man whose fate it is to break up the ley later on.

The creeping thistle can be easily controlled if the farmer is prepared to mow the plants at least twice during the first season. It is remarkable how the creeping thistle population can be reduced by a vigorous use of the mower, beginning well before the thistles have reached their full height. Bullocks will eat young thistles with relish after they have been mown. Frequently the thing that stops the farmer from mowing his thistles properly is hay harvest, or corn harvest: if labour is short thistle mowing can just as well be put out to contract as any other job: certainly it is a most important operation.

Other Weeds.

Sometimes a young ley in fertile soil may be smothered with fat hen, also known as muck-weed or lambs-quarter (*Chenopodium album*). Here again mowing will make a vast difference in the space of a few days, though a second mowing may be needed to deal with the side shoots which are thrown up.

Charlock is occasionally a serious pest, especially if a spring nurse crop like barley or oats is used. It is usually held that to spray charlock with copper sulphate or di-nitro-ortho-cresol (D.N.O.C.) in an undersown straw crop is impossible, because the young seeds are destroyed by the liquid weed killer. There is some truth in this opinion, and it is undoubtedly correct that if young clover seedlings in the cotyledon, or seed-leaf stage, receive a full dose of the spray they will be destroyed. Nevertheless, excellent kills of charlock in oats and barley have been obtained without damage to undersown clovers and grasses by postponing the spraying until both the cereal and the weed are so developed that they completely protect the young seeds from direct contact with the spray.

The same principle can be applied to direct re-seedings which are sometimes seriously menaced by thick growths of charlock. Mowing off a very strong growth of the weed is not altogether satisfactory if the mowings cannot be carted away; a judicious spraying may be more satisfactory though possibly expensive if D.N.O.C. is used. This is certainly to be preferred to sulphuric acid, for it is practically harmless to cereals and grasses.

Management of a Ley Sown in a Cereal Nurse Crop.

Management.

A ley which has been sown in a cereal nurse crop should if possible be grazed as soon as the straw crop has been removed. The grazing should not be severe, particularly if the harvest has been late; a light topping over with sheep or cattle is beneficial because the treading firms the soil, the biting checks any tendency to spindly growth which is encouraged by the shading effect of the cereal. If the seeds mixture contained much red clover, then this early autumn grazing is very desirable, for a lush growth of red clover not only smothers the grasses but encourages the fungus which causes clover rot.

There is evidence that a thin take benefits very much from an application of nitrogen—in some form—soon after the straw crop has been harvested. Of course it is most necessary to remove stock from a young ley during its first autumn if the soil becomes so wet as to poach easily. Poaching or padding the soil is a very effective way of ruining a new ley and must be avoided at all costs. This does not mean that young leys cannot be grazed at all during the first

winter: it merely means that on some stiff soils it is undesirable, and occasionally impossible, to graze in winter without seriously damaging the young sward. On dry soils in dry areas, the land may be sound enough to carry stock almost every day without poaching.

Grazing or Mowing.

There has been a great deal of debate about the advisability of grazing or mowing the ordinary cereal-sown ley during its maiden, or first harvest year. Some speakers and writers have so emphasized the desirability of grazing a ley during its first season that the novice might well imagine that to do otherwise would ruin the turf. Whilst most experienced men agree that proper grazing gives a new ley the fullest chance of establishing itself in a proper manner, experience shows that mowing, if carried out early, is not the terrible thing some people make it out to be. But, of course, it must be an early mow, very much earlier than that practised in an established ley. Otherwise there is the chance of weakening the grasses by allowing them to become spindly, and of checking, or even smothering, the white clover by cutting off its light supply.

Management of an Established Turf.

Sward and Stock.

In order to obtain a proper understanding of the management of established grassland it is necessary to consider certain things about the plants composing a sward, and about the animals which find their food from these plants.

Plants.

First the plants. Stapledon* has crammed a great deal of information into a few words by saying, " Firstly, in proportion as any plant whatsoever is excessively defoliated—that is to say excessively grazed—it will tend to have not only its leafage reduced but also its root system, and more than this, the new leaves formed will be reduced in size. In other words, the plant's functional efficiency will be reduced—reduce any living thing's functional efficiency enough and you are bound to kill it. Secondly plants can withstand heavy defoliation in proportion as they are able to develop side shoots and tillers despite the punishment. Thirdly, plants suffer punishment in direct proportion as they are heavy yielding—that is to say, in direct proportion as they throw up yields quickly after the first few heavy defoliations. Fourthly, other things being equal, plants will be grazed heavily in proportion as they are erect-growing and accessible. Fifthly, it is the erect-growing plants which in the main are less efficient side-shoot and tiller producers than the prostrate plants. Sixthly, heavy punishment at the period of the year when a plant is just beginning to make really active growth is more baneful in its influence than punishment at other times of the year. Consequently, plants which start active growth exceptionally early in the spring—since they, of course, greatly attract the animals, lay themselves more open to severe punishment than do any other plants. Punishment is least baneful when the plant has attained to maximum root development for the year, that is to say, late in the summer."

It is not easy to assimilate at a first reading all the important truths so concisely set out in the above sentences, but they shed much light upon problems of grassland management, particularly if they are considered together with certain other information about palatability.

Palatability.

Palatability, or tastiness, is not the same in all species of grasses and clover. Certain plants are much more attractive to grazing animals than others, or putting it another way, animals like some plants better than others. Here again, Stapledon* has much to say in a few words: " Leaf is much more palatable than stem or sheath—leafage is palatable in proportion as it can grow fast and in proportion as it is growing fast. Directly growth stops, the leafage begins to become unpalatable. Now the leaves of different grass species and strains grow at all sorts of different rates—some go on growing for a long time, but too slowly ever to be of first-rate palatability. Such are bent and the fine-leaved fescues. Perennial rye-grass leaves grow fast enough and long enough to have a long time range of palatability, and that is one reason why it is the king of pasture grasses. Cocksfoot leafage grows at a terrific pace, and is very, very palatable while growing—but unless the grazing keeps pace with the growing it will outstrip the animals, stop growing and become utterly unpalatable. These examples show how nicely balanced the whole thing is, and how the animal influences the situation at every turn."

Stapledon goes on to say that palatability is greatly influenced by the hairiness and harshness of the foliage, and also by the throwing-up of wiry culms or seed-stalks which get in the nostrils or eyes of the grazing animals. Crested dogstail is a notorious offender in the last respect.

Grazing Plants.

From the work carried out at Aberystwyth the principal grazing plants can be arranged in the following order of palatability:—

Timothy.
Italian rye-grass.
White clover.
Perennial rye-grass.

* Four addresses on the Improvement of Grassland (Welsh Plant Breeding Station, 1933).

Cocksfoot.
Meadow fescue.
Meadow foxtail.

Towards the bottom of the scale come Yorkshire fog, bent and the fine-leaved fescues.

Animals.

Of course, what is particularly palatable to one class of farm animal may be much less tasty to another class of stock. All animals do not graze in the same way, and some are much better grazers than others. The order of efficiency in the eyes of the grazier is probably cattle, sheep, horses.

Cattle Only.

Cattle—that is to say store cattle as distinct from dairy cattle—grazing alone will keep grassland in better trim than any other class of stock grazing alone. Not only will they tackle rough grasses quite beyond the capacity of sheep, but they will also graze quite closely a directly re-seeded field containing only rye-grass and clover.

Many an acre of new leys has been made into a satisfactory turf using cattle only, and very many acres of poor, rough herbage have been greatly improved by using strong hungry store cattle as part of the preliminary reclamation work. While dairy cattle graze well, they cannot be expected to help in "reclamation" work on rough pastures and at the same time maintain their condition and their milk yield.

Sheep.

Sheep graze differently from cattle. They concentrate upon "bottom" growth, with the result that pastures continuously grazed with sheep consist almost entirely of dwarf species, particularly perennial rye-grass, crested dogstail, and white clover on the better soils, with larger proportions of agrostis and the fine-leaved fescues on the poorer soils. Grasses like cocksfoot and timothy which need to develop their stems and upper leaves to some extent if they are to survive, either do not live long under constant grazing by sheep or become excessively rank through neglect. It has already been mentioned that hard grazing by sheep may damage new leys.

Horses.

Horses are much less important on farms than they used to be, which is perhaps fortunate for the turf, since horses are extremely bad grazers. They are very selective, eating down bare those patches of turf which they like, while at the same time they neglect entirely certain areas upon which they drop their dung. The consequence is that a field which has been grazed by horses can easily be recognized by the extreme contrast between the grazed and non-grazed areas.

Mixed Grazing.

From what has been said it is clear that mixed grazing is much to be preferred to grazing with one class of stock alone. What is neglected by one class may be appreciated by another, so that the whole of the turf is utilized to the full and is kept in good condition.

But, of course, this does not mean that all classes and all ages of stock should be turned simultaneously into an enclosure.

Cows.

Milking cows or fattening cattle should have first pick at the best pastures, for their needs are greatest. When milking cows have grazed down a field so much that they are likely to have difficulty in obtaining sufficient food to maintain the milk yield, it is time to shift them to another pasture. Dry cows, store cattle or sheep can be run in the first field to pick up a living from what the milking cows have left.

The assumption is made here that enough enclosures are available to permit of this switching about of different classes and ages of stock: but, of course, on many farms this is not the case, and the fields are so large that properly controlled grazing is impossible. Smallish fields, well supplied with water, are essential if the best is to be made of the grassland on a farm. Otherwise it is not possible to apply in practice the information now available about the behaviour of herbage plants under the grazing animal.

Work of Martin Jones.

The classic work of Martin Jones at Jealott's Hill, in Berkshire, has shown very clearly that the botanical nature of a sward can be changed almost at will by controlling the grazing. If control of the grazing is lost, as it is when enclosures get beyond a certain size, then one must expect the value of a pasture to deteriorate—for a good pasture, as a good farmer understands it, is a very artificial thing, whose high standard can only be kept up by ceaseless attention.

Some Basic Conclusions.

On referring back to the remarks of Sir George Stapledon quoted at the beginning of this section and considering them with the points later discussed, it is possible to arrive at some basic conclusions regarding the management of pastures.

First, management in the spring of the year has a tremendous influence upon the pasture for the rest of the season. If the turf is bared right down continuously just as the rye-grass or cocksfoot is starting to grow, that species will be handicapped right throughout the season; for the early punishment at this critical stage will not only weaken its foliage but reduce its root system as well. This effect is particularly well marked if the weather in April and May is dry. This reduction in grass production will lead to a

corresponding increase in either the amount of white clover or dwarf weeds.

Second, unless grazing is heavy at about the time when most grasses are forming their seed heads, production will fall because the herbage matures so rapidly that it quickly becomes unpalatable. The animals grazing such a maturing sward naturally become very selective, and if there is *Agrostis* (bent) in the turf it is likely to be avoided just at the time when it is forming its runners. One can say that the most certain way of encouraging bent grass is to over-graze badly in spring, before the bent has anything with which to tempt the animal, and under-graze in July and August, when bent is growing its fastest.

Third, continuous and unrelenting grazing (ranching) kills off the best grasses in much the same way that continuous and unrelenting work kills off the best and most productive workers—simply because they get no chance to recuperate. The sluggards, the slow growers, can amble along at a lower, slower level for much longer. Periodical rest is essential for full production.

Clover and Sward.

When a field is consistently close grazed there is a tendency for white clover to increase very considerably. Some farmers are apt to judge a pasture entirely by the amount of white clover in it: if there is much white clover they look upon the turf as being first class, irrespective of the other plants which may be present. While it is acknowledged by all who have studied the matter that some wild white clover is extremely desirable in, if not essential to, a good sward, yet it is possible to have too much of this plant. This is especially so if the wild white clover is of the extremely small-leaved type. Wild white clover is not so productive as the grasses, and it starts to grow later than they, so that a generous proportion of the better grasses is essential for maximum production throughout the year.

It is possible to decrease the proportion of white clover by varying the management. The use of nitrogenous fertilizers encourages the grasses at the expense of the clover, and if this is combined with longer rest periods between grazings, or with the taking of a hay crop, the clover is checked. This is largely because white clover is a great lover of sunlight, and cannot thrive in shade. By allowing the grasses to grow taller than usual it is possible to reduce the light supply to the clover and so diminish its vigour.

Early-Bite.

Habits of Grasses.

In order to obtain grass very early in the year—" early-bite " as the grazier calls it—it is again necessary to consider the habits of grasses. In the first place only certain species of grass can possibly give an early-bite. A grass like bent or sheep's fescue starts to grow so late in the season that no conceivable treatment can possibly make it produce an early-bite in April. Only the naturally early species, such as cocksfoot, perennial rye-grass and foxtail can be stimulated into exceptionally early growth.

Next, in order to get this early spring growth, the grasses must be rested early in the autumn. If they are grazed late not only are their root systems reduced but they have no chance of laying up any reserve food at the base of their leaves.

Finally, the limiting factor in the early spring growth of plants is lack of nitrogen. Fast growing herbage needs plenty of nitrogen, and to secure an early-bite it is necessary to apply at least one cwt. per acre of sulphate of ammonia or of " Nitro-Chalk " towards the end of February or the beginning of March. On strong soils probably two cwt. per acre will be necessary. Such a dressing of nitrogen should be given only if the soil is known to be properly supplied with lime, phosphate, and—in chalky soils—potash as well.

Mowing.

Mention has already been made of the way in which white clover can be controlled by influencing its light supply through the taking of a hay crop. The occasional mowing of a grazing sward is frequently beneficial in other ways. It tends to even up the turf by cutting all the plants at the same time, and to this extent is a corrective of irregular grazing. It gives the taller grasses like cocksfoot and timothy a chance to develop and strengthen, and in so doing it preserves the variety of the herbage. Conversely, the grazing of a field usually mown for hay may also be beneficial. It controls the coarser grasses and encourages the bottom grasses and white clover, so that a denser turf is obtained.

Mismanagement.

One of the causes for the existence of so much poor grassland prior to 1939 was the practice of mowing the same fields for hay year after year, frequently without the application of any manure. Lack of water and of stock-proof fences was often the primary cause of this mismanagement, but sometimes the poor quality hay which this system produced was sold off the farm, for in the topsy-turvey pre-war world it was almost the only saleable crop the wretched farmer could raise.

Rotational Grazing.

Rotations.

Thus on many farms there were, and still are, acres of grassland continually grazed, and areas continually mown for hay. This system, or lack of system, is condemned by most writers on grassland, who advocate some form of rotational cropping for the grassland on much the same lines as rotations are advocated for the arable land.

H. I. Moore* describes the following 4-year rotation which, he states, " has worked well in the north under an average rainfall of 30 inches."

First year. Grass allowed to make good growth before stock turned in. Then periods of hard grazing alternating with rest periods. Grazed hard in September and then shut up.

Second year. Dressed with nitrogenous fertilizer in February or early March. An early-bite taken in April to May. Grazed lightly in summer, any surplus being mown for silage.

Third year. Hard grazing throughout the year to encourage the clover.

Fourth year. An early cut of hay. This keeps the clovers in check and encourages the early grasses to become strong. The field is shut up in September and is then ready for the first year's treatment again.

Peel† describes a 3-year rotation thus:

First year. Early-bite: The field is dressed with nitrogen at the beginning of February. The early-bite is grazed. The early and hard grazing weakens the early-growing grasses to a certain extent, but a rest in the winter following helps them partially to recover. During the summer the field is grazed and any surplus mown for hay or silage if possible, and if not, cut and allowed to rot.

Second year. A rest during the previous winter helps the early grasses to recover. A dressing of complete fertilizer in February helps also. There is an early-bite as in the first year; this is grazed, and with this second spring-grazing the early grasses are still further weakened. In order to keep the late-starting grasses in check, the field is kept hard-grazed throughout the summer, autumn and winter. Such hard grazing encourages the clover at the expense of the grasses.

Third year. In spring, when once growth has started on the early-bite fields, the field is rested and a hay crop is taken from it in early June. The aftermath is grazed, but the field is rested in September. The rest in spring and again in autumn strengthens the early-growing grasses and prepares them for the early-bite in the following year (the first year).

CULTIVATIONS.

Routine of Mowings.

The mower can be very valuable to the grazier if used with discretion. Continual mowing will keep under control and eventually destroy the creeping thistle. It will also keep in check the various species of buttercup which infest grass-land by preventing them from shedding seed. But the mowing will do more than this if it is used to top over fields which have been bared down irregularly leaving scattered tufts. Stapledon's remarks about the decreasing palatability of grasses as they become older have been quoted, so one would naturally expect these tufts to be neglected when next the stock are turned into the field. Being neglected they are likely to seed, and in this way weed species like Yorkshire fog may increase. If on the other hand the tufts are mown over, all the grasses in the field start from about the same mark; the basal shoots which are caused to spring from the tufts under the stimulus of the cuts are palatable and stand a reasonable chance of being eaten off. This routine of mowing over a pasture is not just a theoretical matter; it is regularly practised by many of the keenest graziers but, naturally, with considerable discretion in a dry season.

The harrowing and rolling of grassland are operations often carried out very thoughtlessly. Frequently in spring one sees horse-drawn or tractor-drawn diamond-link chain harrows being dragged backwards and forwards over a turf, which for a week or so has a well-groomed look about it. But apart from spreading droppings, and possibly in certain soils interrupting the activities of ants, chain harrowing is a waste of time. The harrowing of grassland in spring should be done with a toothed harrow of some sort, either of the link type with spines or spikes, or the zig-zag type, or the spring-tine type. Special " rippers " and " combs " are available, all designed to penetrate the surface turf to some degree and to drag out the dead matter and aerate the soil slightly. For more drastic work implements such as the " pitch-pole " harrow can be used.

Aeration.

More research into the influence of aeration upon the growth of turf is very much needed. Keepers of lawns, bowling greens and golf greens have for years been using implements which pierce the soil to a depth of two or more inches, and they claim that this aeration of the soil has a most beneficial action. At least one type of turf piercer is available for the upkeep of turf on sports grounds and aerodromes, and it is desirable that its value on ordinary farm grassland should be properly investigated.

Rolling.

Rolling is frequently necessary on land that is to be mown for hay in order to put surface stones out of the way of the mower knife. This applies particularly to one-year seeds and to young leys. But on mature turf rolling is not so important, though it is useful after a severe frost to counteract the lifting it causes. Rolling turf on stiff land when it is very wet is just as harmful as it is on a lawn, for it smears the surface and partially chokes the plants.

* *Grassland Husbandry* (1943), p. 34.

† *Grassland Management for the Practical Farmer* (1938), pp. 116, 117.

THE IMPROVEMENT OF ESTABLISHED GRASSLAND

Our author now turns to the consideration of established grassland and its good management: a most important matter, which requires the discussion, in some detail, of many topics. Botanical changes and their significance are explained. The improvement of established grassland (by ploughing out and by surface treatments) is considered in the light of war-time experience. Use of a short rotation is considered against direct re-seeding. Practical details as to ploughing, discing, rolling and so forth are set out. Drainage, fencing, water supply, fertilizers, are all examined together with the use of renovation mixtures, rough cattle and poultry.

Three Noteworthy Phenomena.

DURING years of war we became accustomed to three noteworthy phenomena: (i) when suitable cultivations and fertilizers have been used, remarkably good crops grown upon land ploughed out of very poor old turf, (ii) remarkably poor crops grown upon similar soil from ploughed-out turf when the proper cultivations and fertilizers have been omitted; (iii) the deterioration of much of the permanent grass left unploughed, because of restriction of fertilizers, especially phosphates.

Important Points.

These happenings emphasize a number of important points concerning old grassland as distinct from long leys. The first is that the greatly advertised " fertility " of much old grassland just did not, and does not, exist. Thousands of acres of inferior old turf were, and still are, far from being a reserve of fertility: they were, and are, in many cases a reservoir of humus, or decaying vegetable matter, but they were and are, quite unable to support any crop (including grass) unless first supplied with lime, phosphate, potash and, usually, nitrogen. Of course *good* old grassland, well looked after and properly manured, either through the grazing animal or by means of dung or fertilizers, is able unaided to grow crops when ploughed up: but neither the *Agrostis*-fescue, nor the *Agrostis*-with-weeds type of turf is capable of doing this. Good turf grows good grass, while poor turf neither grows grass nor is capable of growing any other good crop when ploughed up.

This leads to the second point, which is that old turf may need different treatment from leys of four to six years duration.

Close Turf.

One of the characteristics of ageing grassland on many soils is the formation of a close turf, accompanied by the development of a " mat," or accumulation of decaying vegetation on the surface of the soil. The development of a close sward is very desirable on grazing land, because until this happens on strongish soils it is not possible to run cattle in wet weather without serious poaching or padding of the ground. A certain small amount of dead matter is inevitable in a close old sward and helps to support the feet of cattle. But if the mat develops beyond a certain point—it is not easy to say what this point may be—it interferes very seriously with the feeding and health of the plants. It is one of the causes of the choking out of the better grasses, such as rye-grass and timothy, and an encouragement for bent grass, fescues and other species which can live more successfully in poor circumstances.

Poor Management.

The deterioration of grassland is hastened by poor management: by over-grazing in spring when the good grasses are just starting to grow vigorously: by under-grazing in summer and autumn, when flower heads are forming: by continuous over-grazing or continuous under-grazing: by continued mowing for hay: all these mismanagements tend to alter, for the worse, the botanical composition of a turf. The continual removal of phosphate and lime in milk, in bone or in hay without renewal through caking or fertilizing, hastens the degeneration of a turf, and on acid soils makes inevitable the formation of a mat.

IMPROVING GRASSLAND.

When grassland has sunk into the extreme *Agrostis*, or *Agrostis*-fescue-plus-weeds condition, it is not an easy task to improve matters. The mere application of fertilizers must not be expected to bring about sensational results in one season. The important thing to remember is that some grasses will respond quickly to better conditions, while other grasses are incapable of making this response, no matter how well they are fed. Rye-grasses, timothy, cocksfoot and to a less extent crested dogstail will react at once to doses of phosphate and nitrogen. *Agrostis*, the smaller fescues, and other less useful grasses cannot be stimulated in the same way into additional vigour and growth by fertilizers. That is one of the reasons why such grasses are looked upon as worthless in the eyes of the farmer.

BOTANICAL CHANGE.

Consequently, bearing these points in mind, it should become obvious that before a poor old *Agrostis* or similar pasture can be turned into even a moderately good pasture, the *Agrostis* and inferior plants will have to be crowded out to a large degree by some better, more responsive plants. Above all it is vital to introduce white clover. In other words the botanical nature of the grassland will have to be changed.

This problem does not, or should not, arise with long leys. The essence of ley farming is to plough out the ley *before* it begins to deteriorate.

Botanical Change.

Assuming, then, that before the old turf can become really productive it must undergo a botanical change, how can this be encouraged? There are two principal ways of setting about the job. One can either plough up, or cultivate up completely, the old turf and start afresh by seeding the land down with a proper seeds mixture: or, recourse can be made to surface treatments, so as gradually to improve the sward without actually destroying it.

Cheaper to Plough.

Experience during wartime has shown that it is quicker, and in many cases cheaper, to plough up an old turf and start again from the beginning rather than attempt improving a sward by surface treatments.

Two Alternatives.

When an old turf is ploughed out, the farmer has two alternatives. He can either re-seed immediately upon the upturned sod, or he can grow a number of crops before putting the field back to grass. Fields which are level and conveniently placed are probably best put through a rotation before being re-seeded, for the following reasons. The first is that, given satisfactory prices for farm products, the crops will largely, if not entirely, pay the expenses of the re-seeding. Secondly, cropping the land for several seasons, with the cultivation this involves, brings about the complete destruction of the old turf. This in itself makes the " take " of seeds more certain, for it permits better consolidation. Another advantage is that lime and fertilizers become thoroughly mixed up in the soil.

Re-seeding.

Sometimes the re-seeding is carried out in the first and only straw crop. During the war years this crop was frequently winter wheat, which like spring oats, sometimes suffered greatly from wire-worm attack. If it is possible to break up an old turf on stiff soil in June or July, and work it as a bastard-fallow by repeatedly cross-ploughing or cultivating until it is time to plant wheat in early October the chance of wireworm damage is very greatly reduced. At the same time the disintegration of the turf makes it possible to consolidate the land more thoroughly, and thus to assist both the wheat and the seeds sown in spring.

From the point of view of establishing seeds it is possibly better to plant in the first crop than in the second. There is always the risk of bringing unrotted turf to the surface when ploughing for the second crop. For this reason some farmers on strong land do their re-seeding either in the first or in the third straw crop, never in the second crop.

Direct Re-seeding.

Fields which are awkwardly placed, say at the very extremity of a farm, or directly between two other fields having no other communication; fields which give access to water; fields which are too steep or undulating for arable cropping; or fields in hilly and wet districts, may have to be re-seeded direct, without a cereal nurse crop. Preparations may be made for this either by ploughing or by disc harrowing, or by a combination of the two.

If it is decided to plough, it is important to recall that all the available evidence shows the desirability of making a direct re-seeding upon a stale furrow rather than upon a fresh one. That is, it is better to plough before Christmas than in early March. But, unless the land is to be properly bastard-fallowed, the ploughing should not be done before November: otherwise the turf will grow up between the furrows and interfere with spring cultivations. If the ground is ploughed before Christmas it has several months to settle down and consolidate itself throughout the whole depth of the furrow; this consolidation can be imitated very poorly by rollings and discings hurriedly carried out on a turf which is ploughed in spring. Consolidation can be accomplished by these cultivations—but at a much greater cost than if nature does the work!

Nature's Tilth.

Further, exposure to rain and frost will break down clay soils very much better than any man-made implement can. The awkward sticky clays of the Lower Lias formation, and the strong Keuper Marls, for instance, fall into a fine tilth, or " sugar mould," after a winter's exposure in the furrow, and then almost no cultivation at all in spring is needed prior to sowing the seeds.

Careful Ploughing.

The importance of careful ploughing can scarcely be over-emphasized. It saves much subsequent labour and leads to better results. The ideal to aim at in a winter ploughing is the complete burying of all turf, and a slight cocking up of the edge of the furrow slice so as to get a generous amount of thoroughly weathered mould by spring. To obtain this it is necessary to level off any ant-hills, otherwise the plough will ride over them and cause uneven work. Disc harrows make light work of ant-hills.

Depth of Ploughing.

Depth of ploughing conforms to differences in the soil. Old turf on river meadows where the soil is a deep alluvium may be ploughed as deep as a foot in order to bury and immobilize any weed seeds existing in the top few inches. On medium, easy-working land it does not matter very much at what depth the ploughing is done. But on stiff clays it is undesirable to plough very deeply (unless a fallow is contemplated) for the subsoil may not mellow sufficiently during winter. So long as all the turf is buried, three to four inches may be deep enough in these conditions.

A spring ploughing for a direct re-seed demands even more care than a winter ploughing, for here there is no ameliorating effect of weathering to offset mistakes. The furrow slice must be cut shallow and turned right over to go in neatly with its neighbours. Some ploughs have an adjustment whereby the disc-coulter can be tilted so as to undercut the furrow slice, and this sometimes assists in laying the slices over neatly with a close join.

A good rolling before the disc harrows are used helps to keep the turf well covered, and the discs should be used first in the direction of ploughing with the same object. Repeated discings not only produce a fine tilth but also assist to firm the soil. Some farmers go so far as to run their rubber-wheel tractors wheel mark to wheel mark right across a field in order to bring about the desired consolidation.

Practical details regarding liming, fertilizing, and sowing the seeds are given on pp. 317–319.

Ant Hills.

As in the case of a winter ploughing if the surface of the field is covered with ant-hills it is necessary to remove these in order to make a good job of ploughing. This removal may be carried out with a strong cultivator or scuffle, or with disc harrows.

Pre-discing the turf before ploughing is advocated by some authorities, the object being to disintegrate the turf and hasten its rotting. Pre-discing is also said to make later consolidation easier to achieve. This may not always be the case, for a fluffed-up mat is sometimes difficult to turn in properly and remains springy.

Discing.

Unfortunately we have not a great deal of accurate information concerning the advisability or otherwise of pre-discing in the case of ploughing for a direct re-seed. Even disc harrowing means spending money, and we ought to be certain that the extra cost of pre-discing will be returned in some other way before recommending it for every occasion. Many farmers prefer to do an extra discing or two *after* ploughing, rather than before ploughing.

Re-seeding of course, can be carried out without using the plough at all, and numerous good swards have been established on old turf which has been disc harrowed into a suitable condition. To get the best results from a disc re-seed it is desirable to start in good time and continue the discing through the dry period of summer: in fact, to carry out a disc fallow. In this way the old turf is completely killed, and some at least of the seedlings springing from buried weed seeds are also destroyed. On stiff land it is an additional advantage to leave the disced surface exposed all winter to frost, rain and wind: an excellent tilth is then obtained.

Discing in Spring.

If discing is performed in spring immediately before the seed is sown, it is quite certain that a proportion of the old turf will come back to life as soon as the final rolling has been given. Consequently the re-seeding starts off with a handicap which cannot be avoided if this hurried procedure is adopted. This is not to say that immediate discing in spring prior to a direct re-seeding is of no value. Tremendous improvements can be brought about by the method, but it is as well to face the fact that a disc-re-seeding of this type has disadvantages compared with a more leisurely discing programme, or with a programme which includes ploughing.

Cost of Ploughing.

It is very difficult to give figures of the cost of ploughing-out old turf and re-seeding direct, because there are so many different circumstances. In 1945, assuming the seeds mixture used was priced at about 70/- per acre, one could say the whole operation might then cost between £8 and £10 per acre. During the war years this charge could be offset by the ploughing grant of £2 per acre, making the net cost £6–£8 per acre.

If it is impracticable to plough up an old turf which it is desired to improve, other methods must be used. Changes must be made in what for want of a better word may be called " estate management," in the general management, and in the fertilizer programme.

Estate management includes such items as drainage, fencing and the provision of water.

Drainage.

The importance of adequate drainage should need no emphasis. The better grasses and clovers cannot exist where land is waterlogged, and where rushes, sedges and similar water-living plants take their place. If the land is excessively wet without being actually waterlogged there is not only a continual struggle between the productive and the non-productive species—with a consequent lowering of the yield—but also the number of grazing days per season is reduced because the wet ground is soon churned up by stock.

Such spectacular results have been obtained in all parts of the country from the brooking, ditching and drainage schemes of the war years that little need be said here about them. All the operations are expensive, particularly tile-drainage schemes: to some degree the less costly system of drawing mole drains can be adopted, though the effective life of a mole drain is very uncertain.

Water-Logged Soil.

It sometimes happens that a wet grass field shows many of the symptoms of a water-logged soil from a very different cause. A thick, acid mat may have formed on the surface of the soil, and a mat of this sort takes a long time to " wet " properly. Water just cannot penetrate and run down into the subsoil. This peculiarity can be very well seen soon after the autumn rains have begun. Neighbouring fields may be thoroughly

soaked to a depth of several inches, but removal of a square of turf with an acid mat reveals a bone-dry, dusty soil beneath. The mat holds the water on the surface, and partially drowns the herbage. The remedy is to bring about the decomposition of the mat by lime and harrows.

Fencing.

Fencing is an important item both in the improvement and maintenance of turf. Unless the grazing can be controlled it is useless to spend money upon improving turf. One of the reasons why much of the grassland of the country was so poor in pre-war years was the neglect of fences: stock roamed from one field to another and ranch conditions soon developed.

Generally speaking, it is desirable to have grazing fields not exceeding about 20 acres, though of course on large farms with plenty of stock much larger enclosures are successfully managed. Considerably smaller fields give a better control, of course, and some small dairy farmers have found it profitable to split their ley fields into paddocks of three to four acres each.

Electric Fences.

Opinions differ greatly about electric fences. Properly erected and looked after they provide the cheapest form of fencing against cattle it is possible to obtain. For sheep they are not so satisfactory. If not looked after electric fencing can be very disappointing: one of the difficulties on many farms is maintaining proper insulation, since even a single bracken stem can short-circuit the whole fence. It is very desirable that the potential user of an electric fence should carefully consider all the desirable features of the fence and measure these against any special difficulties which his own holding presents.

Water.

The provision of water is closely related to fencing problems. Unless water is, or can be made, available, at least fairly conveniently, it is useless to think of improving an old turf. The grazing animal is an essential part of any turf improvement scheme, and without adequate water the proposition is not feasible. The ideal arrangement is a naturally flowing or a piped water supply to every enclosure. If animals have to go long distances to water, crossing several enclosures in doing so, the handicaps to turf improvement are too great for satisfactory results.

Assuming that drainage, fencing and water supply are satisfactory, the next steps relate to surface cultivations and fertilizers. Spring is the time to begin these operations.

Ant-hills can be levelled off by disc harrows, by cultivators, or by flat heavy baulks of timber lashed together and drawn behind a tractor, or they can be laboriously chopped off by hand. The soil can be spread by ripper or toothed harrows.

Dead Surface Vegetation.

If there is much dead surface vegetation ("feg"), an excellent preliminary operation is a thorough burn over in March when the feg is dry and readily ignites. It is as well to take care of the fences before they, too, catch fire. If it is impossible to begin operations before the new herbage grows up through the old feg, thus making it unburnable, the mower may have to be used to remove the tall growth. But it is surprising how much can be done with the pitch-pole harrows to remove this material.

Drastic Cultivations.

Drastic cultivations can then be commenced, and for these the pitch-pole harrows, which are self cleaning, are excellent. Disc harrows, unless set very straight are liable to chop the turf up too much. What is wanted is a dragging out of feg and a scratching up and exposure of the top soil.

Lime.

This is an excellent time to apply lime if that is needed, for the more thoroughly the lime is mixed up with the mat the quicker and more efficiently does it do its job. To harrow an acid turf without simultaneously applying lime is a waste of time and effort. A scratched but unlimed acid turf soon heals its scars and is not a whit improved. Types of lime have already been described. Except on peaty soils the full lime requirement as disclosed by soil analysis should be applied. On peaty soils, which have an insatiable need of lime, a compromise has to be reached; the help of the Advisory Chemist should be sought as to the most useful quantity of lime to apply.

The more drastic the harrowing the better: it must be severe to do good, and because it must be severe it is desirable to carry out the work well in advance of dry, sunny weather conditions which may "drought out" the land.

Fertilizers.

Liming and harrowing are not sufficient in themselves, fertilizers are needed as well. Phosphate and nitrogen are the chief requirements, the phosphate chiefly to make conditions suitable for the clovers which this class of old turf so sadly lacks, and nitrogen to encourage vigorous and palatable growth of the herbage.

Phosphate.

It does not matter a great deal which form of phosphatic fertilizer is used (see p. 318); on some soils response to phosphate may not take place until the potash position has been put right. Often it may be more convenient to use a proprietary compound fertilizer containing nitrogen and phosphate or, in soils which badly need it, potash as well. Some of these compounds contain the more soluble ammonium phosphate,

which acts rather more quickly than a mixture of superphosphate and sulphate of ammonia. If such very soluble compounds are used it is necessary to repeat the dose the following season, since the effect of the manure is not so lasting as it is when basic slag is employed. On old turf at least five cwt. per acre of a medium-to-high grade slag, and one cwt. of sulphate of ammonia or " Nitro-Chalk " will be needed: an application of as little as two cwt. per acre of a highly concentrated compound may supply as much plant food as the above dressing; in remote districts the saving in labour and transport may more than offset the extra cost of the compound.

Wild White Clover.

It has already been stated that old turf of the type being discussed is short of wild white clover. It is very desirable to introduce this plant as early as possible during the renovation, and the best way of doing this is to buy some reliable cleanings from commercial white clover seed. When wild white clover, or S. 100 white clover, is harvested the clover seed contains a proportion of seeds of perennial rye-grass, crested dogstail, and grassland weeds. After cleaning there is left a mixed residue of the smaller seeds of white clover plus the foreign seeds, and these cleanings can be purchased quite cheaply, at a price which depends upon the proportion of white clover seed present and the nature of the weed seeds. Provided the proportion of weed seeds is low (and in the case of S. 100 white clover special notice should be taken of any dock seeds) these cleanings make an excellent renovation mixture for old turf when obtainable at round about 1/9–2/- per lb. About five pounds per acre of such cleanings should be sufficient to introduce white clover and some of the better grasses into the turf. They can be scattered by hand or dropped on top of the fertilizer in the manure distributor.

Managing the Growth of Herbage.

Harrowing, liming, fertilizing, seeding—these are the preliminaries. The most important part of the work is looking after the growth which springs up as a result of these treatments. It is absolutely essential to have sufficient stock on hand to bite down the herbage while it is still young and palatable. Hard grazing is vital, and if neglected the preliminary effort is largely wasted. Consequently it is desirable to limit the renovation to an area which can be fully stocked. It is better to turn a large number of cattle or sheep into a smallish area to bite off the vegetation in a short time rather than to have a smaller number taking a long time over the business. Bite down hard, remove the stock for a few days, bite down hard again and so on: the on-and-off system works well in renovations as in ordinary practice. For this work, of course, strong store cattle are the most suitable. If by any mischance the vegetation does get beyond the animals it should be removed by mowing over.

It is remarkable what the urine and dung of cattle and sheep will do in the way of herbage improvement when they fall upon exposed soil as distinct from matted vegetation. If dung lies on a vegetable mat the manurial value is mostly wasted, whereas on a heavily scarified turf the dung becomes incorporated in the soil, fertilizes any young seedlings, and together with organic nitrogen in the urine begins to rot down the mat itself.

Progressive Change.

If the treatment that has been described is repeated in general outline for a season or two the botanical nature of the turf undergoes a progressive change for the better. There is a reduction in the amount of bent and fescues, and an increase in such plants as white clover, meadow grasses, crested dogstail, and perennial rye-grass. This increase can only be maintained if the lime in the soil is kept at a satisfactory level, and if phosphate and nitrogen are supplied as well. The phosphate is essential for clover, and the nitrogen for rapid growth of the grasses so that they may remain palatable to stock. Anything which enriches the soil, such as the feeding of hay and cake to stock is of course beneficial.

The Stock.

The finishing touch can be given only by the stock. Without them no permanent improvement is possible, and unless the stock are sensibly managed even they are of limited use.

In certain circumstances pigs are excellent animals with which to start operations upon a poor old turf. If they can be conveniently housed and properly confined they will, especially if un-ringed, rout about and cultivate the soil very cheaply, at the same time manuring it heavily. They will consume large numbers of dock roots, which is an additional advantage. After the old turf has been more or less destroyed the pigs can be removed, and cultivations begun in preparation either for sowing a renovation mixture or for a thorough re-seeding.

Poultry.

Between the two wars poultry were used on a big scale to improve the poor thin turf on certain Chalk Downs. The birds were housed in folding units each holding 20–25 adults. The units were moved every day so as to cover one acre of land every year. The scratching and the droppings of the birds which, of course, received the generous feed of grain possible at that period, resulted in an increase in the proportion of clover and better grasses and a reduction in the proportion of the small fescues so characteristic of the Chalk Downs. The nutritive value of the herbage was much improved as the result of this system, the percentage of crude protein, lime and phosphoric acid being much higher after the folding.

WINTER FODDER FROM GRASSLAND

Methods of preserving grass for use during the winter are now described. The various considerations that govern the making of hay of good quality are discussed, such as the botanical nature of the herbage, fertility of the soil, time of cutting, method of curing and storing and so forth. The use of salt and the employment of mechanical balers receive attention. Molassed grass silage and its manufacture come under review, and the value of pits for economical storage is stressed. A brief account of methods of making dried grass concludes the section and the book.

Winter Fodder.

Although it is probably true to say that the chief use made of grassland in these islands is grazing during the open months of the year, yet a considerable area is devoted to the production of fodder for consumption in and around the farm buidings during winter.

In 1939, in England and Wales just over 4½ million acres of permanent grass were mown for hay, against 11 million acres grazed. In 1944 the figures were 2½ million acres mown and 7½ million acres grazed. In 1939 some 1½ million acres of temporary leys were mown, and in 1944 the area was nearly 2 million acres.

Fodder produced from grassland can be preserved in three different forms—as hay, as silage and as dried grass. Hay has been made from time immemorial, but the extended use of grass silage is comparatively recent, and the manufacture of dried grass on a commerical scale began only about 1935.

Hay.

In essentials, hay is grass which has been allowed to dry in the sun until the moisture content is so low that moulds and bacteria are unable to work on it and cause mouldiness and decay. If the hay is to keep in good condition its moisture content—after it has finished sweating in the stack—should usually not exceed 14–15 per cent.

Good Hay.

But, of course, the making of good hay is not merely a matter of extracting water from a miscellaneous herbage. All sorts of considerations arise, such as (1) the botanical nature of the fodder to be cut for hay; (2) the fertility of the soil producing the fodder; (3) the time of cutting; (4) the method of curing, or making; (5) the method of storage. These points will be discussed in turn.

(1) Botanical Nature of the Fodder.

Grasses and Clovers.

A very large number of chemical analyses of grasses and clovers has been made upon plants at about the hay stage. From these analyses we known certain important facts. We know that some grasses are naturally less nutritious than others, and that some species lose their value after they have flowered very much more quickly than others. We know, also, that in general the clovers are relatively much more full of protein than the grasses. We know, too, that the leaves of grasses and clovers are much more nutritious, weight for weight, than the stems.

Grasses which grow slowly, such as *Agrostis*, the smaller fescues and so on, contain relatively more fibre than the more rapidly growing species such as rye-grass and timothy. The naturally leafy grasses are more likely to give good hay, other things being equal, than the naturally stemmy types.

(2) Fertility of the Soil.

Good Soil.

Good quality grass, and consequently good quality hay, cannot be grown upon land which is deficient in the materials needed for proper growth. Ling has recently shown that the application of lime to an acid meadow leads immediately to an improvement in the quantity of lime in the hay. In one experiment application of approximately 30 cwt. per acre of ground limestone increased the percentage of lime (calcium oxide) in the dry matter of the herbage from 0·70 per cent to 0·86 per cent in the first year. The improvement was maintained at this level for the second year, but thereafter a rapid falling off took place. These figures emphasize the desirability of regularly liming meadow land which is naturally inclined to be short of lime.

The same principle holds good with phosphoric acid. Land naturally short of phosphates cannot yield a phosphate-rich hay. When a phosphate such as bone, slag or superphosphate, is applied to meadow land the percentage of phosphoric acid in the dry matter of the herbage jumps upwards—or in other words, the quality of the hay improves. This is a beneficial reaction quite distinct from the improvement in quality due to an increase in the clover content of the herbage.

According to Ling, one ton of average quality hay removes from the soil the equivalent of 178 lb. of sulphate of ammonia, 67 lb. of basic slag, and 41 lb. of ground limestone. These figures should be read in conjunction with what has already been said concerning the manuring of grassland for hay.

Nitrogen, of course, is necessary for the manufacture of protein in the plant. It is well understood that nitrogenous fertilizers increase the bulk of a hay crop, though an excess may lead to trouble at cutting through lodging. Only recently, however, has it been discovered that an application of sulphate of ammonia three weeks before cutting markedly increases the digestible

protein in the hay. What use can be made of this discovery in every-day practice has yet to be decided, but it certainly has interesting possibilities. If the fertilizer is put on by a distributor when the grass is dry no permanent damage is done, as the plants soon get up again. Any nitrogen not used by the hay crop goes to increase the growth of the aftermath.

(3) Time of Cutting.

Experiment and experience both indicate the superior quality of hay from grass which has been cut early compared with hay from grass cut late. Grasses are completely mature when their seeds have ripened and dropped off the flower heads; what is left of the parent plant is very largely fibre, of little value to an animal except as a provider of bulk, for it is mainly indigestible. But long before a grass is fully mature the proportion of fibre rapidly increases. So soon as the seeds begin to form, the woody material increases relative to the softer, more digestible, more nutritious parts of the plant.

Maximum Development of Nutrients.

In practice it may be said that the largest weight per acre of grass combined with the maximum development of nutrients, occurs just as the grasses and clover *begin* to flower. If grass is cut for hay an appreciable time before this flowering takes place a very nutritious hay should result, but the crop may be a light one. If cutting is delayed for some time after flowering the quality will certainly diminish, and possibly the bulk also.

Leaving the grass another week in order to increase bulk is a common practice, but it may be illusory in that respect. The real weight of a crop of meadow hay, if not seeds hay, depends more upon the " bottom " growth than upon the top growth, and it is quite possible for this bottom growth to begin shrinking while the general appearance of the crop gives the illusion of an increase. So far as bulk of good *food* per acre is concerned, hay cut on the early side wins easily.

A Misconception.

One still hears it said that the value of hay lies in the seeds which form in the ears of the grasses, but a moment's reflection shows the absurdity of the statement. Quite apart from the losses which take place through the dropping out of the seeds during the handling of the hay, the formation of seeds is always accompanied by an increase in the indigestible fibre and a decrease in the digestible nutrients of the parent plants; the stem and leaves are, in fact, robbed of their food materials which are transported and stored up in the seed for the future generation.

All plants used in leys or found in meadows do not flower at the same time. For example, Black Medick (Yellow Trefoil) flowers very much earlier than Broad Red Clover, and may even be almost shrivelled away to nothing before the clover is ready to cut. The ideal to aim at is to cut when the most valuable plants in the hay are just about to flower.

Early Cutting.

Generally speaking most hay is left too long before cutting. Cutting a fortnight before one thinks the crop should be ready is possibly a good rule to adopt if good quality hay is the object aimed at.

If a large acreage has to be cut it is obviously necessary to begin quite early, otherwise the last hay cut will be over ripe.

(4) Method of Curing.

When labour was plentiful the making of hay was a rite, followed out with anxious care. The grass after cutting was turned, and raked, and shaken, and heaped, and shaken out again, and heaped and shaken out and so on, all by hand. It had to be just-so before being carried and as often as not in this fickle climate the final product was inferior to that obtained by the more slap-dash methods of today because of the wetting it received during the prolonged operations.

The object of hay-making is to dry out the grass as rapidly as possible with the minimum exposure to the sun and the least possible movement.

Curing Grass.

These simple aims are so frequently lost sight of in the mist of tradition which surrounds hay-making, that it is desirable to restate them and bear them in mind in what follows. Grass should be cured (i.e., have its moisture content reduced from 75–80 per cent to below 20 per cent) as soon as possible, because exposure to the sun reduces the carotene content very quickly, and because rain washes out some of the most soluble, and valuable, elements. Grass should be moved as little as possible because all movement tends to knock off leaves, and leaves form the most valuable portion of grasses and, in particular, of clovers.

If these statements are accepted, it follows that there are only two main common-sense methods of making hay: one is to rush the hay into the rick in the fastest possible time consistent with safety, and the other is to let the hay cure itself in large, watertight cocks until it can be moved to its winter quarters. The first method is particularly applicable to large scale, mechanized methods in what is normally a dryish climate, while the second method is specially suited to small scale farming in normally wet districts.

In trying to rush the process as much as possible the use of a hay kicker or tedder the same day as the grass is cut is recommended. Some mowing machines actually have kicking devices attached to them so as to move the swath at once.

The heavy swath is consequently not left lying undisturbed, imprisoning damp air between itself and the ground, what time the upper surface becomes bleached by the sun. Freshly cut grass can be tedded or kicked quite vigorously without damage, and is then left loose for the air to circulate and to carry away the moisture. This immediate tedding may save from one to two days in the curing of hay. It may also improve the quality, since the turning of a heavy, half-baked, half-sopping wet swath can easily result in the loss of an appreciable amount of leaf.

Exact Conditions.

Once the hay is ready to carry—and no text-book instruction can explain exactly when this condition has been reached—the most rapid method of putting it into a place of safety is through the use of a hay sweep. This involves making a rick in the field, and the disadvantages which this involves during the winter are usually offset in the mind of the farmer by the increased chances of saving the hay in good condition, untouched by rain.

Devices.

The combination of tractor hay sweep and mechanical stacker provides the most rapid of all methods of ricking hay. The sweep pushes a load of hay right into a device resembling another sweep lying on the ground between two tall supports: by means of a tractor or a stationary engine this second " sweep " is caused to rise and catapult the entire load on to the stack. Other devices are the usual engine-driven elevator and the hay fork.

If the hay is to be taken to the buildings, then a hay loader attached to the wagon saves time and labour.

Hay can safely be ricked at a higher moisture content if salt is sprinkled over it while it is being built into the stack. The usual recommendation is approximately 1 per cent of salt, that is 20 lb. salt per ton of hay. Experiments suggest that grass of up to about 30 per cent moisture can be stacked if salt is used, whereas without it, the moisture content should not exceed 10–20 per cent.

Hay carried without being wetted by rain is more liable to overheat in the rick than hay which has had a good washing. The warming-up of hay is due at first partly to respiration of the plant cells and partly to bacteria and moulds which multiply at the expense of the soluble sugary matter in the grass. If much of this has been washed out, the organisms are kept short of food and do not multiply so rapidly.

North-Country Method.

If rapid methods of hay-making cannot be adopted, because of lack of equipment or labour or small size and awkward nature of the fields, then the north-country method of curing the hay in cocks is probably the most reliable system to adopt. These ricks are from 8–10 feet high as made, and they are built up of grass which would not normally be thought nearly fit enough to carry in the traditional methods of the midlands and south.

If tripods or other ventilating devices are used, round which the material is arranged, the hay can be in a very unripe condition. Because of the air channels the hay will dry out and make in about three weeks. If no tripods are used the hay should be, as it were, half made, and it will then finish the curing process in the rick.

In this system there is no attempt to make the hay by repeated shakings-out each followed by a raking together. Once in the cock the hay is safe, if the cock is well made, with vertical sides and a properly shaped and raked top. Both labour and anxiety are reduced.

The cocks are removed to the permanent site when convenient. The larger cocks may be hauled intact onto low, flat vehicles for transport.

(5) Method of Storage.

Mention has already been made of the use of salt in the making of hay and little more need be said about the rick. The desirability of thatching a hay rick as soon as it has been completed is very great, though a rick with a steeply pitched roof, thoroughly raked and re-raked, will throw off a surprising amount of rain. There is no need to wait for the rick to " settle " before thatching.

Hay baling from the field is comparatively new. One method is to have a stationary baler, to which the hay is propelled by sweeps: usually a single baler does not fully occupy the time of one tractor sweep. The other method is to use a baler with a pick-up attachment which makes the bales as the machine straddles the windrows. Up to two tons of hay bales per hour is the usual output.

Most balers use wire, a few string. The one-man pick-up baler using twine is becoming very popular on the larger farms.

Bales.

Hay may be baled rather sooner than it can be ricked, but surface moisture on the hay may lead to mouldiness in the bale. When hay is baled in a moist condition the bales should be made looser than when the hay is dry, so that the excessive moisture may escape. For this reason some farmers like to leave their bales standing out on their ends in the field for a day or two before collecting them. With a moisture content of about 30 per cent the density of the bale should be 8–11 lb. hay per cubic foot, whereas with hay at about 20 per cent moisture (i.e., hay fit to stack) the density can be increased to 14 lb. per cubic foot.

Bales tied with string are packed tight, but wired bales are best stacked with narrow gaps

between them. Bales should be placed on their narrow sides. Ricks made of stacked bales should, of course, be thatched at once to keep out rain.

The baling of hay offers great advantages in storage and utilization. Much space is saved and if the bales are of a uniform size and weight the rationing of hay during the winter is greatly simplified.

Making Silage.

The making of silage from young grass is a recent innovation which received a great deal of publicity at the beginning of the war because of the great shortage of imported feeding stuffs. The process is based upon a sound theoretical foundation dating from the discovery by Woodman and his co-workers that young vigorously growing grass contains a very high proportion of digestible protein. The proportion is so great in really young grass that the herbage is similar in feeding value to linseed cake, but, of course, as the grass becomes older so the proportion of protein diminishes, and the percentage of carbohydrate and fibre increases.

During attempts to preserve this young grass by the methods of ensilage long practised on specially grown fodder crops such as oats and vetches, it was found that the proportion of sugary matter in the grass is too low to encourage the vigorous growth of bacteria and moulds. These organisms give rise to certain organic acids, chiefly lactic and acetic acids, which later on act as preservatives and prevent the silage from growing mouldy.

To encourage fermentation the device of adding a solution of crude sugar to the grass has been adopted with very satisfactory results. As the grass is shaken out in the silo or pit about 20-lb. of molasses per ton of fodder are sprinkled over it. This is best done by diluting 1½ gals. of molasses with an equal volume of water and sprinkling the solution with an ordinary watering can.

Three Important Points.

To make really good quality grass silage three important points have to be observed. (1) The grass must be young; (2) the temperature during the filling of the silo must be controlled; (3) air must be excluded before the silo is sealed.

The importance of young grass for first-quality silage has already been emphasized. Good silage cannot be made from old, stemmy material.

In order that the requisite lactic and other acids may be formed, the fresh material after being molassed must be allowed to heat up. The temperature should rise to about 90 to 100 degrees Fahrenheit, and this should be measured with a thermometer. If the material is trodden down too tight as it is filled into the container the temperature will not rise because the air is excluded, and at this stage some air is essential. If the material is left too loose the temperature may rise far above 90 degrees F., and the silage will then turn dark brown, and although it will remain palatable its digestibility and feeding value will be much reduced. The temperature, therefore, can be controlled by the degree of compactness in the silo. If the temperature does not rise, feed the material in more loosely and wait a day until the desired heat is forthcoming. If the silage gets too hot, trample it down firmly.

Air must be excluded after the rise in temperature has taken place, otherwise decay and loss will take place due to the action of other fungi and bacteria. To keep out the air silage is usually made in some sort of container, though stack silage can be usefully made.

Containers ranging from the wire netting cylinder lined with waterproof paper to the wooden and concrete tower silos have all been used, and all these are useful in that the silage can be made at a place convenient to the buildings.

Pit Silo.

There is, however, a growing realization that the cheapest and least wasteful of all containers is a hole in the ground, otherwise called a pit silo. These pits can be excavated very cheaply by the tractor-operated scoops now available, and can be situated in almost any sort of soil, provided the drainage is attended to and provided the walls are not liable to cave in.

A pit 15 ft. across at the top, with sides sloping to 12 ft. at the bottom and 4 ft. deep, will hold about 5 tons of grass per yard of its length.

When the pit is filled to a height of about one foot above the top of the pit a layer of straw is put on top of the silage and a few inches of earth are spread on top of the straw. The tractor excavator, or scoop, previously referred to can much simplify the work if the covering is begun at one edge and gradually worked forward. The more the tractor travels over the material and consolidates it the better.

Sealed off in this way grass silage will keep in excellent condition for quite two years if necessary with only the very narrowest of uneatable material at the edge.

Heavy Work.

The labour of cutting and loading grass silage deters many farmers, and there is no denying that ensilage does involve heavy work. The larger expensive " cutlift " machines are not within the pockets of all farmers, but there are now available small, light and comparatively cheap grass elevators which can be towed behind the mower to cut and fill a low trailer in one operation. It is also possible to convert some hay tedders to load sledges drawn behind.

Silage making is much less at the mercy of the weather than hay making, and often fits in quite well with the organization of a mainly grass farm. Filling is not bound to be an every-day job, as it

may be necessary to fill on alternate days in order to permit of the right fermentation temperature. The young aftermath of a hay crop can, if suitably fertilized, give a heavy and nutritious crop of silage, while young grass and clover leys also give excellent silage.

Properly made, grass silage may contain over 18 per cent of crude protein based on the dry matter. Samples with over 20 per cent of crude protein are not uncommon; on this analysis approximately 17 lb. silage can replace 3½ lb. of concentrates in the dairy ration.

In the making of molassed silage approximately 10 per cent of digestible crude protein in the grass is lost; in hay making at least 25 to 30 per cent of the crude protein is lost.

In considering the value of grass silage one ought not to overlook the benefit to a pasture which results from the mowing of the herbage in a young state. A man who sets himself out to obtain a high protein silage by manuring his grass properly, and by cutting it early, not only obtains a valuable home-grown fodder, but also keeps his grassland in excellent condition for both grazing and hay purposes, with a proper balance between the grasses and clover.

Silage making and hay making on the same farm should not be antagonistic, but complementary. Some hay will always be wanted, and the aftermath of the hay crop can very well be made into silage. The two things combined enable the farmer to make a much fuller use of his land.

Grass Drying.

Mention has already been made of Woodman's discovery that young grass has a very high proportion of protein. The question at once arose: Is it possible to preserve the protein for winter feed by drying the grass on a commercial scale? Since about 1935 the answer has been "Yes" and, but for the war, great improvements in grass dryers would have been made.

Carotene and Protein.

Properly carried out grass drying preserves not only the protein, but also the carotene of the grass. Carotene is the forerunner of the important Vitamin A which beneficially affects the health of animals, and incidentally gives milk a satisfying colour. Carotene exists chiefly in the green parts of plants, and this is why hay is low in carotene; the substance disappears during the bleaching action of the sun while the hay is being made.

Carotene is looked upon as being so important that at one time it took priority over the protein content in the assessment of the value of dried grass. It is estimated in milligrammes of carotene per kilogramme of dried grass.

The grass dryer consists essentially of a furnace, fired either by coke or by oil, and a drying chamber equipped with a fan, or fans, to circulate hot air through the grass and drive off the moisture. The problem is to reduce the moisture content of the grass from about 75 to 80 per cent to about 3 per cent in the shortest possible time without at the same time damaging the nutrients it contains. The initial water content of the grass can be reduced by allowing the herbage to wilt before carrying it; but the advantage so gained is offset by the necessity for another field operation in collecting the wilted material.

There are various types of dryer; one type has movable trays to hold the grass; in another the grass moves slowly and continuously through a drying chamber on an endless conveyor; another type of dryer uses rotary drums.

Province of the Engineer.

The actual drying is the province of the engineer, not the farmer, and it is probable that in a few years' time machines will be developed capable of driving off the moisture from grass more quickly and more economically than existing dryers. At present the output in dryers is low, being in the region of 3–5 cwt. of dried grass per hour, at a water ratio of 4 to 1 (i.e., when 4 parts of water have to be evaporated to produce 1 part of dried matter).

After drying, the grass is usually baled under pressure, each bale containing about ¾ cwt. Some users of grass dryers put the product through a hammer mill, reducing it to a fine powder which is put into paper bags and sold as a concentrated food.

The National Farmers' Union recommends the purchase of dried grass, only upon a declaration of protein or carotene. The recommended scale of prices for 1949 varied from £18 per ton for a protein value of 11 per cent, to £29 per ton for 19 per cent protein. The recommended price for Beta Carotene was 2s. per unit, with a minimum price of £18 per ton.

In order to run a grass dryer economically a certain minimum acreage of grass is obviously necessary. For existing dryers probably 70 to 80 acres would be needed. A considerable amount of organization is also required, not only as regards labour for the actual drying, but also for the cutting and carrying. The manurial programme, too, requires thought.

A considerable expansion in grass drying is not possible until steel and labour once again become available for manufacturing the dryers, which were unobtainable during the war. Possibly developments will take place in two directions—large capacity dryers for the large farms, and small, perhaps portable, dryers for the less extensive farms. More efficient drying systems can confidently be expected.

SECTION VI

GOOD FARM BOOK-KEEPING

by

A. C. CAMPBELL

INTRODUCTORY NOTE

It is often said by the farming community that as our grandparents farmed successfully for several decades without the use of accounts, we should be able to do the same.

Our grandparents did not farm in times like the present and from the many changes that have taken place in the past hundred years it would be altogether wrong to exclude the farmer's problems. For example, we might be reminded that slightly over one hundred years ago the people of this country were called upon to meet a serious obligation; they were informed that a tax on income was to be fixed at sevenpence in the pound. Again, it might be interesting to remember that at one period the people were not called upon to pay any tax on income at all.

If the majority of farmers had followed the lead of one of their number who, from 1851, kept Farm Management records, financial and otherwise, we should in all probability have escaped from much of the chaos that has been experienced in the farming business ever since.

This book is not meant to rectify the situation by a stroke of the pen. It is written for the guidance of students, young farmers, and other farmers who would like to have some idea of the methods used in making records of their farm management by means of Farm Accounting.

A good system of Farm Accounts provides the farmer with a record of his capital and how it is distributed. It brings to his notice excessive expenses which are separated by the accounts and which without accounts would never be noticed. His future planning will be largely guided by observations made from his accounts. Expenditure on manures, feeding stuffs and on improvements is recorded, and the records provide the necessary particulars for compensations on change of tenancy and in other claims. The necessary administration particulars are quickly obtained if and when desired.

Apart from the Chancellor of the Exchequer's invitation to keep better farm records, it will be an advantage, when taking the long view, for farmers on all sized holdings to make full use of their Accounts.

It is generally agreed that farming must not be allowed to fall back into its pre-war state and it has also been generally stated that farming cannot be run in days of peace on the high prices and returns of war-time. If the industry cannot run on its own machinery, the Government is the most likely source of help. When assistance from a Bank is wanted, the Banker naturally asks for certain business particulars and the Government is bound to ask for some authoritative evidence that industry is in need of financial assistance, and the most simple method of dealing with such a situation is to be in possession of such data.

GOOD FARM BOOK-KEEPING

The author gives us an immediate and interesting insight into the method of keeping farm accounts. He illustrates his subject by a simple set of clear examples. He points out for us the objects and principles of the Balance Sheet and deals, successively, with the meaning and use of the Double Entry System of Accounting, the Ledger and Real, Personal and Nominal Accounts. This leads on, naturally to the working of a complete set of Farm Accounts. The section is brought to a close with an explanation of Capital in Cash.

The undermentioned example is given to illustrate to the beginner the general lay-out of a simple set of Farm Accounts worked on the Double-Entry accounting system.

BALANCE SHEET OF J. CROWE

29th September, 1948

LIABILITIES.	£	s.	d.	ASSETS.	£	s.	d.
Sundry Creditors—				Cash	2,000	0	0
Landlord	400	0	0	Cattle	1,200	0	0
D. Perry	70	0	0	Horses	300	0	0
L. Brown	110	0	0	Pigs	20	0	0
Capital	5,620	0	0	Hay	130	0	0
				Oats	700	0	0
				Barley	400	0	0
				Wheat	500	0	0
				Implements	570	0	0
				Feeding Stuffs	15	0	0
				Manures	10	0	0
				Sundry Debtors—			
				B. Horne	90	0	0
				C. King	265	0	0
	£6,200	0	0		£6,200	0	0

CAPITAL ACCOUNT

Dr.	£	s.	d.	Cr.	£	s.	d.
To Balance	6,081	0	0	By Balance	5,620	0	0
				,, Profit & Loss A/c.	461	0	0
	£6,081	0	0		£6,081	0	0

CASH ACCOUNT

Dr.		£	s.	d.	Cr.		£	s.	d.
1948					1949				
Sept. 29	To Balance	2,000	0	0	—	By Landlord	400	0	0
1949	,, Horne A/c.	90	0	0		,, Implements	150	0	0
	,, King A/c.	265	0	0		,, D. Perry	70	0	0
	,, Cattle A/c.	900	0	0		,, Feeding Stuffs	40	0	0
	,, Pigs A/c.	45	0	0		,, Wages	600	0	0
	,, Barley	650	0	0		,, Rent	400	0	0
	,, Wheat	600	0	0		,, General Expenses	59	0	0
	,, Oats	450	0	0		,, Seeds	40	0	0
						,, Manures	100	0	0
						,, Balance	3,141	0	0
		£5,000	0	0			£5,000	0	0
	To Balance b/d	3,141	0	0					

CATTLE ACCOUNT

Dr.		£	s.	d.	Cr.		£	s.	d.
1948					1949				
Sept. 29	To Valuation	1,200	0	0	—	By Cash A/c.	900	0	0
	,, Profit & Loss A/c.	400	0	0	Sept. 29	,, Valuation	700	0	0
		£1,600	0	0			£,1600	0	0
	To Valuation b/d	700	0	0					

HORSES ACCOUNT

Dr.		£ s. d.	Cr.		£ s. d.
1948			1949		
	To Valuation	300 0 0	—	By Profit & Loss A/c.	30 0 0
			Sept. 29	,, Valuation	270 0 0
		£300 0 0			£300 0 0
	To Valuation b/d.	270 0 0			

PIGS ACCOUNT

Dr.		£ s. d.	Cr.		£ s. d.
1948			1949		
Sept. 29	To Valuation	20 0 0	—	By Cash A/c.	45 0 0
	,, Profit & Loss A/c.	35 0 0	Sept. 29	,, Valuation	10 0 0
		£55 0 0			£55 0 0

HAY ACCOUNT

Dr.		£ s. d.	Cr.		£ s. d.
1948			1949.		
Sept. 29	To Valuation	130 0 0	Sept. 29	By Valuation	100 0 0
				,, Profit & Loss A/c.	30 0 0
		£130 0 0			£130 0 0

OATS ACCOUNT

Dr.		£ s. d.	Cr.		£ s. d.
1948			1949.		
Sept. 29	To Valuation	700 0 0	—	By Cash A/c.	450 0 0
	,, Profit & Loss A/c.	400 0 0	Sept. 29	,, Valuation	650 0 0
		£1,100 0 0			£1,100 0 0
	To Valuation b/d.	650 0 0			

BARLEY ACCOUNT

Dr.		£ s. d.	Cr.		£ s. d.
1948.			1949		
Sept. 29	To Valuation	400 0 0	—	By Cash A/c.	650 0 0
	,, Profit & Loss A/c.	500 0 0		,, J. Walker	150 0 0
				,, Valuation	100 0 0
		£900 0 0			£900 0 0

WHEAT ACCOUNT

Dr.		£ s. d.	Cr.		£ s. d.
1948			1949		
Sept. 29	To Valuation	500 0 0	—	By Cash A/c.	600 0 0
	,, Profits & Loss A/c.	500 0 0	Sept. 29	,, Valuation	400 0 0
		£1,000 0 0			£1,000 0 0

IMPLEMENTS ACCOUNT

Dr.		£ s. d.	Cr.		£ s. d.
1948			1949		
Sept. 29	To Valuation	570 0 0	Sept. 29	By Valuation	648 0 0
1948	,, Cash A/c.	150 0 0		,, Profit & & Loss A/c.	72 0 0
		£720 0 0			£720 0 0
	To Valuation b/d.	648 0 0			

FEEDING STUFFS ACCOUNT

Dr.		£ s. d.	Cr.		£ s. d.
1948			1949		
Sept. 29	To Valuation	15 0 0	Sept. 20	By Valuation	10 0 0
1949	,, Cash A/c.	40 0 0		,, Profit & Loss A/c.	45 0 0
		£55 0 0			£55 0 0
	To Valuation b/d.	10 0 0			

MANURES ACCOUNT

Dr.		£ s. d.		Cr.	£ s. d.
1948			1949		
Sept. 29	To Valuation	10 0 0	Sept. 29	By Valuation	12 0 0
1949	" Cash A/c.	100 0 0		" Profit & Loss A/c. ..	98 0 0
		£110 0 0			£110 0 0
	To Valuation b/d.	12 0 0			

B. HORNE ACCOUNT

Dr.		£ s. d.		Cr.	£ s. d.
1948			1949		
Sept. 29	To Balance	90 0 0	Sept. 29	By Cash A/c.	90 0 0

C. KING ACCOUNT

Dr.		£ s. d.		Cr.	£ s. d.
1948			1949		
Sept. 29	To Balance	265 0 0	—	By Cash A/c.	265 0 0

LANDLORD ACCOUNT

Dr.		£ s. d.		Cr.	£ s. d.
1949			1948		
—	To Cash A/c.	400 0 0	Sept. 29	By Balance	400 0 0

D. PERRY ACCOUNT

Dr.		£ s. d.		Cr.	£ s. d.
1949			1948		
—	To Cash A/c.	70 0 0	Sept. 29	By Balance	70 0 0

L. BROWN ACCOUNT

Dr.		£ s. d.		Cr.	£ s. d.
1949			1948		
—	To Balance	110 0 0	Sept. 29	By Balance	110 0 0

WAGES ACCOUNT

Dr.		£ s. d.		Cr.	£ s. d.
1949			1949		
—	To Cash A/c.	600 0 0	Sept. 29	By Profit & Loss A/c. ..	600 0 0

RENT ACCOUNT

Dr.		£ s. d.		Cr.	£ s. d.
1949			1949		
—	To Cash A/c.	400 0 0	Sept. 29	By Profit & Loss A/c. ..	400 0 0

GENERAL EXPENSES

Dr.		£ s. d.		Cr.	£ s. d.
1949			1949		
—	To Cash A/c.	59 0 0	Sept. 29	By Profit & Loss A/c. ..	59 0 0

SEEDS ACCOUNT

Dr.		£ s. d.		Cr.	£ s. d.
1949			1949		
—	To Cash A/c.	40 0 0	Sept. 29	By Profit & Loss A/c. ..	40 0 0

J. WALKER ACCOUNT

Dr.		£ s. d.		Cr.	£ s. d.
1949			1949		
—	To Barley A/c.	150 0 0	Sept. 29	By Balance	150 0 0

PROFIT AND LOSS ACCOUNT

		£ s. d.			£ s. d.
1949			1949		
—	To Horses	30 0 0	—	By Cattle	400 0 0
	" Hay	30 0 0		" Pigs	35 0 0
	" Implements	72 0 0		" Oats	400 0 0
	" Feeding Stuffs	45 0 0		" Barley	500 0 0
	" Manures	98 0 0		" Wheat	500 0 0
	" Wages	600 0 0			
	" Rent	400 0 0			
	" General Expenses ..	59 0 0			
	" Seeds	40 0 0			
	" Capital A/c. being Net Profit	461 0 0			
		£1,835 0 0			£1,835 0 0

BALANCE SHEET OF J. CROWE

29th September, 1949

LIABILITIES.

1949		£ s. d.
—	To Sundry Creditors—	
	L. Brown	110 0 0
	Capital	6,081 0 0
		£6,191 0 0

ASSETS.

1949		£ s. d.
—	By Cash	3,141 0 0
	,, Cattle	700 0 0
	,, Horses	270 0 0
	,, Pigs	10 0 0
	,, Hay	100 0 0
	,, Oats	650 0 0
	,, Barley	100 0 0
	,, Wheat	400 0 0
	,, Implements	648 0 0
	,, Feeding Stuffs	10 0 0
	,, Manures	12 0 0
	,, Sundry Debtors—	
	J. Walker	150 0 0
		£6,191 0 0

Many methods of approach to the subject have been devised, but one very good starting point in dealing with Farm Accounts is to get right down to business and to make a Balance Sheet.

This will let the farmer see the amount of Capital that is invested, and how such Capital is distributed throughout the farm. It will indicate the value of Cattle, Horses, Sheep, Pigs, Poultry and Dairy Produce, Machinery and Implements, Oats, Barley, Wheat, Hay and Straw, Potatoes and Roots, Growing Crops and Tillages, Purchased Foods, Artificial Manures, Farmyard Manure, Unexhausted Improvements, Cash in Hand, Cash in the Bank and all other Assets of the business.

This list will also include debts owing to the Farmer by Persons or Firms who are known as Sundry Debtors.

Before completing the Balance Sheet it is also necessary to make a list of the Liabilities of the Farm. These are debts (owing by the Farmer) to Persons or Firms who are known as Sundry Creditors at the date on which the Balance Sheet is constructed.

By taking the total amount of the Assets and by deducting the total amount of the Liabilities, a balance will be seen which is known as the Capital. If, however, the Liabilities exceed the Assets, the Balance is known as a Deficiency and the farmer is said to be insolvent.

The following simple illustration will clearly show the construction and contents of the Balance Sheet:—

BALANCE SHEET OF A. SMITH ON 31st MARCH, 1949

LIABILITIES.

	£ s. d.
Sundry Creditors—	
P. Evans	40 0 0
F. Black	80 0 0
Landlord	160 0 0
Capital	13,175 0 0
	£13,455 0 0

ASSETS.

	£ s. d.
Cash in Hand	20 0 0
Cash in Bank	2,000 0 0
Valuation—	
Cattle	4,655 0 0
Horses	700 0 0
Sheep	650 0 0
Pigs	20 0 0
Poultry & Dairy Produce	40 0 0
Machinery & Implements	1,250 0 0
Oats	110 0 0
Barley	220 0 0
Wheat	100 0 0
Hay & Straw	300 0 0
Potatoes & Roots	700 0 0
Growing Crops & Tillages	2,000 0 0
Purchased Foods	20 0 0
Artificial Manure	50 0 0
Farmyard Manure	70 0 0
Unexhausted Improvements	400 0 0
Sundry Debtors—	
W. Brown	60 0 0
S. Jones	90 0 0
	£13,455 0 0

Double Entry.

As soon as the Balance Sheet is completed, a decision has to be made on the procedure of recording the Farm transactions for the year.

In this particular case they will be dealt with in what is known as the Double Entry System of keeping Accounts, which means that every transaction throughout the year will have two entries. The first one will be known as the Debit entry, and the second one will be known as the Credit entry. It also means that two Accounts are affected by every transaction.

The System is operated through the Ledger. The left-hand page of this book is termed the Debit side, and the opposite page is referred to as the Credit side. Both pages are ruled into columns showing the Date, the Particulars of the transaction, and the money involved. The Book contains a classified and summarized record of all the transactions that are entered under the various Accounts.

These Accounts are classified into REAL ACCOUNTS, PERSONAL ACCOUNTS and NOMINAL ACCOUNTS.

LEDGER

Dr. Date	Particulars.	£ s. d.	Date.	Particulars.	Cr. £ s. d.

EXAMPLES OF REAL ACCOUNTS

CASH ACCOUNTS

Dr.		£ s. d.			Cr. £ s. d.
—	To Balance	40 0 0	—	By Wages	15 0 0
	„ Eggs	20 0 0		„ Gen. Expenses	5 0 0
				„ Balance	40 0 0
		£60 0 0			£60 0 0

WHEAT ACCOUNT

Dr.		£ s. d.			Cr. £ s. d.
—	To Valuation	700 0 0	—	By Bank A/c.	400 0 0
	„ Profit & Loss A/c.	100 0 0		„ Bank A/c.	250 0 0
				„ Valuation	150 0 0
		£800 0 0			£800 0 0

IMPLEMENTS ACCOUNT

Dr.		£ s. d.			Cr. £ s. d.
—	To Valuation	750 0 0	—	By Depreciation	75 0 0
				„ Valuation	675 0 0
		£750 0 0			£750 0 0

PERSONAL ACCOUNTS

J. BROWN'S ACCOUNT

Dr.		£ s. d.			Cr. £ s. d.
—	To Cattle A/c.	400 0 0	—	By Bank A/c.	600 0 0
	„ Sheep	200 0 0			
		£600 0 0			£600 0 0

LANDLORD'S ACCOUNT

Dr.					Cr.
—	To Balance	£200 0 0	—	By Rent A/c.	£200 0 0

NOMINAL ACCOUNTS

RENT ACCOUNT

Dr.		£ s. d.			Cr. £ s. d.
—	To Bank A/c.	200 0 0	—	By Profit & Loss A/c.	400 0 0
	„ Landlord's A/c.	200 0 0			
		£400 0 0			£400 0 0

WAGES ACCOUNT

Dr.	£ s. d.	Cr.	£ s. d.
— To Cash A/c.	10 0 0	— By Profit & Loss A/c.	60 0 0
„ Bank A/c.	50 0 0		
	£60 0 0		£60 0 0

DEPRECIATION ACCOUNT

Dr.	£ s. d.	Cr.	£ s. d.
— To Implements A/c.	75 0 0	— By Profit & Loss A/c.	125 0 0
„ Horse A/c.	50 0 0		
	£125 0 0		£125 0 0

Real Accounts.

Real Accounts are accounts of property and possessions, such as Cash, Land, Building, Livestock or Implements. A Rule is applied to these different classes of Ledger Accounts, and the Rule for Real Accounts is to DEBIT VALUES RECEIVED, and to CREDIT VALUES GIVEN.

For example, if we sell Cattle for Cash we see that the two Accounts affected are the Cash Account and the Cattle Account. Now apply the Rule. " Debit values received and Credit values given." The Cash Box receives the Cash, and the Cattle Court which is looked upon as the Cattle Account gives out the Cattle.

The left-hand side of the Account is the Debit side, and the right-hand side of the Account is the Credit side.

The transaction would appear in the Accounts in this way:—

CASH ACCOUNT

Dr.		Cr.	
To Cattle A/c.	£100 0 0		

CATTLE ACCOUNT

Dr.		Cr.	
		By Cash A/c.	£100 0 0

Assume that the following transactions covered the whole of the Cattle Transactions for the year. From that assumption it is possible to see what the Cattle Account and the Cash Account look like at the end of the year.

Sold Cattle for cash, £100. Sold cattle for cash, £200. Sold cattle for cash, £300. Sold cattle for cash, £400. Purchased cattle for cash, £300. Purchased cattle for cash, £200. Purchased cattle for cash, £100.

In the first transaction the Cash Box or Cash Account received £100, and the Cattle Account gave £100.

CASH ACCOUNT

Dr.		Cr.	
To Cattle A/c.	£100	By Cattle A/c.	£300
„ Cattle A/c.	200	„ Cattle A/c.	200
„ Cattle A/c.	300	„ Cattle A/c.	100
„ Cattle A/c.	400		

CATTLE ACCOUNT

Dr.		Cr.	
To Cash A/c.	£300	By Cash A/c.	£100
„ Cash A/c.	200	„ Cash A/c.	200
„ Cash A/c.	100	„ Cash A/c.	300
		„ Cash A/c.	400

The Farmer purchased cattle for £300. The Cattle Court or Account received the value of £300, and the Cash Box or Account gave £300. By applying the Rule it is seen that the Cattle Account is debited, and the Cash Account is credited.

All the Accounts must be closed at the end of the year. The first Account to be balanced is the Cash Account. On adding the debit side it is seen that the total receipts amount to £1,000, while the total of the credit side is £600, leaving a balance of cash on hand of £400.

CASH ACCOUNT

Dr.		Cr.	
To Cattle A/c.	£100	By Cattle A/c.	£300
„ Cattle A/c.	200	„ Cattle A/c.	200
„ Cattle A/c.	300	„ Cattle A/c.	100
„ Cattle A/c.	400	„ Balance	400
	£1,000		£1,000

When the Cattle Account is balanced it will be seen that £1,000 worth of cattle were sold, and £600 worth of cattle were purchased, which leaves a profit of £400.

CATTLE ACCOUNT

Dr.			Cr.
To Cash A/c.	£300	By Cash A/c.	£100
,, Cash A/c.	200	,, Cash A/c.	200
,, Cash A/c.	100	,, Cash A/c.	300
,, Profit & Loss A/c.	400	,, Cash A/c.	400
	£1,000		£1,000

Farmers as a rule do not sell all their cattle off the farm during the year. Many animals are on the pasture or in the courts both at the beginning of the year, and at the end of the year. Suppose the valuation of the cattle at the beginning of the year was given at £1,000, and the value at the end of the year amounted to £1,100, a slight change would be seen in the Cattle Account. In fact, the profit would be increased by £100.

CATTLE ACCOUNT

Dr.			Cr.
To Valuation	£1,000	By Cash A/c.	£100
,, Cash A/c.	300	,, Cash A/c.	200
,, Cash A/c.	200	,, Cash A/c.	300
,, Cash A/c.	100	,, Cash A/c.	400
,, Profits & Loss A/c.	500	,, Valuation	1,100
	£2,100		£2,100

It might be said that farmers do not pay £300 in cash and receive £400 in cash, and that they transact such business through the Bank by means of Cheques. This is correct. In fact, it cannot be too strongly emphasized that farmers and all other business men ought to make most of their payments, especially the large amounts, by Cheque.

The only difference such procedure would make to the above examples would be seen in the absence of a Cash Account and in the presence of a Bank Account.

BANK ACCOUNT

Dr.			Cr.
To Cattle A/c.	£400	By Cattle A/c.	£300
,, Cattle A/c.	300	,, Cattle A/c.	200
,, Cattle A/c.	200	,, Cattle A/c.	100
,, Cattle A/c.	100	,, Balance	400
	£1,000		£1,000

Personal Accounts.

When the Farmer transacts credit transactions with persons or firms, it is necessary to introduce Personal Accounts. The Rule applied to these accounts is to " DEBIT THE RECEIVER AND CREDIT THE GIVER." The Farmer buys artificial manures from Tom Walls and agrees to pay in 30 days. The two accounts affected in the transaction are the Personal Account and the Manures Account. The Rule is to Debit the Receiver and to Credit the Giver. Tom Walls gives the Manures and therefore his Account is credited. The second entry is a Debit entry and is found in the Manures Account.

TOM WALLS' ACCOUNT

Dr.			Cr.
		By Manures A/c.	£100

MANURES ACCOUNT

Dr.			Cr.
To Tom Walls' A/c.	£100		

When the date of payment is due, the Farmer hands Tom Walls a cheque for £100, and that transaction has to be recorded. The two Accounts that receive attention here are the Bank Account and Personal Account. Tom Walls receives the Cheque and we Debit the Receiver. The Credit entry will be found in the Bank Account.

TOM WALLS' ACCOUNT

Dr.			Cr.
To Bank A/c.	£100	By Manures A/c.	£100

BANK ACCOUNT

Dr.			Cr.
		By Tom Walls' A/c.	£100

It will be seen that the Creditor's Account, which is the Personal Account, has now been opened, settled, closed and balanced in accordance with the Rule for Personal Accounts.

Further Personal Account entries would be recorded if the Farmer sold Barley to Tom Baxter for £500. Tom Baxter is the Receiver and his Account is therefore debited. The other account, the Barley Account, would be credited.

TOM BAXTER'S ACCOUNT

Dr.			Cr.
To Barley A/c.	£500		

BARLEY ACCOUNT

Dr.			Cr.
		By Tom Baxter's A/c.	£500

The Farmer then decides to purchase Feeding Stuffs from Tom Baxter. The Rule is to credit the giver and since Tom Baxter gives the Feeding Stuffs his Account is credited, and the Feeding Stuffs Account is debited.

TOM BAXTER'S ACCOUNT

Dr.			Cr.
To Barley A/c.	£500	By Feeding Stuffs A/c.	£400

FEEDING STUFFS ACCOUNT

Dr.			Cr.
To Tom Baxter's A/c.	£400		

Tom Baxter sends a cheque in settlement of his Account, and since he is the giver, we credit his Account with £100 and debit the Bank Account.

TOM BAXTER'S ACCOUNT

Dr.			Cr.
To Barley A/c.	£500	By Feeding Stuffs A/c.	£400
		,, Bank A/c.	100
	£500		£500

BANK ACCOUNT

Dr.			Cr.
To Tom Baxter's A/c.	£100		

Nominal Accounts.

On passing on to the third type, it is found that they are accounts of Profit and Loss such as Rents, Wages, Bad Debts, Discount, Interest and Depreciation.

The Rule applied to Nominal Accounts is to Debit Losses or Expenses and credit Gains.

The Farmer pays the half-year's Rent by Cheques, £200. This transaction would be recorded in the Rent Account and in the Bank Account. The Rent Account is debited (since the Rule says Debit Losses or Expenses), and of course it is necessary to meet these expenses before a profit can be expected from the Farm. The other entry, the credit entry, would be recorded in the Bank Account.

RENT ACCOUNT

Dr.			Cr.
To Bank A/c.	£200		
,, Landlord's A/c.	£200		

BANK ACCOUNT

Dr.			Cr.
		By Rent A/c.	£200

The second half-year's rent is due, and the Farmer owes the Landlord £200. The Rent Account is again debited and the Credit entry is carried away to the Landlord's Account.

LANDLORD'S ACCOUNT

Dr.			Cr.
		By Rent A/c.	£200

Supposing that it is the end of the year and these Accounts have to be closed. The Rent is taken to the Profit and Loss Account as a Loss or Expense to be placed against the Profits or Gains.

RENT ACCOUNT

Dr.			Cr.
To Bank A/c.	£200	By Profit & Loss A/c.	£400
,, Landlord's A/c.	£200		
	£400		£400

The Personal Account shows a Liability as it indicates that the Farmer still owes the Landlord £200.

LANDLORD'S ACCOUNT

Dr.			Cr.
To Balance	£200	By Rent A/c.	£200

The word Balance is written in the Personal Account, and it is taken down with the other Liability Balances to the Final Balance Sheet at the end of the year.

The Wages Account is another Nominal Account that is constantly in use.

£60 has been drawn from the Bank for wages. Here the Wages Account is debited and the Bank is credited.

WAGES ACCOUNT

Dr.			Cr.
To Bank	£60	By Profit & Loss A/c.	£60

BANK ACCOUNT

Dr.			Cr.
		By Wages A/c.	£60

When closing the Wages Account at the end of the financial year, the entry of £60 is transferred to the Profit and Loss Account.

It is seen that a Balance Sheet has been prepared and since Real Accounts, Personal Accounts and Nominal Accounts have been opened, written up, and closed, it is now possible to venture on a complete elementary set of Farm Accounts. That can be done by preparing a list of the particulaıs and transactions during the Farm's Financial Year. The Farmer can write up the Ledger from these items, and then proceed to prepare a Profit and Loss Account, and a Balance Sheet.

On the 1st of April, 1943, the Cash in hand was £30, and in the Bank £1,500. The Valuation of Cattle amounted to £2,000, Sheep £400, Implements and Machinery £900, Crops £800. John Dale owed him £100, and F. Jack owed £120. He owed the Landlord £40.

These are the particular found in the Records of Adam Eden, Clayhill Farm.

At this stage it is very helpful for the student to become the farmer Adam Eden and so conduct the management and the farm transactions on his own behalf.

His transactions during the year were:—

			£
April	7th	Bought Feeding Stuffs from J. Gray	24
May	10th	Sold Cattle to M. Mason ..	£150
June	18th	Paid the Landlord by Cheque ..	40
July	13th	Received cheque from Mason and paid the cheque into the Bank	150
Aug.	28th	Sold sheep at the Market and paid the cheque into the Bank ..	240
Sept.	24th	Purchased Seed Wheat from Gray	26
Oct.	11th	Purchased Cattle and paid by Cheque	180
Nov.	28th	Purchased Feeding Stuffs from Gray	30
Dec.	17th	Sold Potatoes to Brown ..	28
Jan.	3rd	Paid half year's Rent	150
Feb.	19th	Bought Implement from Bromley	33
Mar.	26th	Sold Cattle and paid the Cheque into the Bank	1,200
,,	26th	Sold Oats and Wheat and received Cheque	400
,,	28th	Paid Gray Cheque in settlement of his Account	80
,,	28th	Purchased Cattle and paid Cheque	250
,,	29th	Paid Wages during the Year ..	300
,,	29th	Paid Cash for General Expenses for Year	9
,,	30th	Half-Year's Rent due	150

At the end of the year the valuations were Cattle £2,300. Sheep £250. Implements and Machinery £830. Crops £500.

Ledger.

BALANCE SHEET OF ADAM EDEN, 1st APRIL, 1949

Dr. LIABILITIES.	£ s. d.	Cr. ASSETS.	£ s. d.
— To Sundry Creditors.		— By Cash in Hand	30 0 0
,, Landlord	40 0 0	,, Cash in Bank	1,500 0 0
,, Capital	5,810 0 0	,, Valuations—	
		Cattle	2,000 0 0
		Sheep	400 0 0
		Implements	900 0 0
		Crops	800 0 0
		,, Sundry Debtors—	
		John Dale..	100 0 0
		F. Jack	120 0 0
	£5,850 0 0		£5,850 0 0

CAPITAL ACCOUNT

Dr. Date.	Particulars.	£ s. d.	Date.	Particulars.	Cr. £ s. d.
1950			1949		
Mar. 31	To Balance	6,456 0 0	April 1	By Balance	5,810 0 0
				,, Profit & Loss A/c.	646 0 0
		£6,456 0 0			£6,456 0 0
				By Balance b/d...	£6,456 0 0

CASH ACCOUNT

Dr.		£ s. d.			Cr. £ s. d.
—	To Balance	30 0 0	Mar. 29	By General Expenses	9 0 0
			,, 31	,, Balance	21 0 0
		£30 0 0			£30 0 0
	To Balance b/d.	£21 0 0			

BANK ACCOUNT

Dr.		£ s. d.			Cr. £ s. d.
	To Balance	1,500 0 0	June 18	By Landlord	40 0 0
July 13	,, Mason's A/c.	150 0 0	Oct. 11	,, Cattle A/c...	180 0 0
Aug. 28	,, Sheep A/c.	240 0 0	Jan. 3	,, Rent A/c.	150 0 0
Mar. 26	,, Cattle A/c.	1,200 0 0	Mar. 28	,, Gray's A/c.	80 0 0
Mar. 26	,, Crop A/c.	400 0 0	Mar. 28	,, Cattle A/c...	250 0 0
			Mar. 29	,, Wages	300 0 0
			Mar. 31	,, Balance	2,490 0 0
		£3,490 0 0			£3,490 0 0

CATTLE ACCOUNT

Date.	Particulars.	£ s. d.	Date.	Particulars.	£ s. d.
	To Valuation	2,000 0 0	May 10	By M. Mason's A/c.	150 0 0
Oct. 11	,, Bank A/c.	180 0 0	Mar. 26	,, Bank A/c.	1,200 0 0
Mar. 28	,, Bank	250 0 0	Mar. 31	,, Valuation	2,300 0 0
	,, Profit & Loss A/c.	1,220 0 0			
		£3,650 0 0			£3,650 0 0

SHEEP ACCOUNT

Dr.		£ s. d.			Cr. £ s. d.
—	To Valuation	400 0 0	Aug. 28	By Bank	240 0 0
	,, Profit & Loss A/c. ..	90 0 0	Mar. 31	,, Valuation	250 0 0
		£490 0 0			£490 0 0

IMPLEMENTS AND MACHINERY ACCOUNT

Dr.		£ s. d.			Cr. £ s. d.
	To Valuation	900 0 0	Mar. 31	By Valuation	830 0 0
Feb. 19	,, Bromley's A/c.	33 0 0		,, Profit & Loss A/c. ..	103 0 0
		£933 0 0			£933 0 0

CROPS ACCOUNT

Dr.		£ s. d.			Cr. £ s. d.
—	To Valuation	800 0 0	Dec. 17	By Brown's A/c.	28 0 0
	,, Profit & Loss A/c. ..	128 0 0	Mar. 26	,, Bank	400 0 0
			Mar. 31	,, Valuation	500 0 0
		£928 0 0			£928 0 0

JOHN DALE'S ACCOUNT

Dr.					Cr.
			1950		
	To Balance	£100 0 0	Mar. 31	By Balance	£100 0 0

F. JACK'S ACCOUNT

Dr.	£ s. d.	Cr.	£ s. d.
— To Balance	£120 0 0	1950 Mar. 31 By Balance	£120 0 0

LANDLORD'S ACCOUNT

Dr.	£ s. d.	Cr.	£ s. d.
June 18 To Bank A/c.	40 0 0	Mar. 2 By Balance	40 0 0
1950 Mar. 31 ,, Balance	150 0 0	Mar. 30 ,, Rent A/c.	150 0 0
	£190 0 0		£190 0 0

FEEDING STUFFS ACCOUNT

Dr.	£ s. d.	Cr.	£ s. d.
April 7 To J. Gray's A/c.	24 0 0	Mar. 31 By Profit & Loss A/c. ..	54 0 0
Nov. 28 ,, J. Gray's A/c.	30 0 0		
	£54 0 0		£54 0 0

J. GRAY'S ACCOUNT

Dr.	£ s. d.	Cr.	£ s. d.
Mar. 28 To Bank	80 0 0	April 7 By Feeding Stuffs	24 0 0
		Sept. 24 ,, Seeds A/c.	26 0 0
		Nov. 28 ,, Feeding Stuffs	30 0 0
	£80 0 0		£80 0 0

H. MASON'S ACCOUNT

Dr.	£ s. d.	Cr.	£ s. d.
May 10 To Cattle A/c.	£150 0 0	July 13 By Bank	£150 0 0

SEEDS ACCOUNT

Dr.	£ s. d.	Cr.	£ s. d.
Sept. 24 To J. Gray's A/c.	£26 0 0	— By Profit & Loss A/c. ..	£26 0 0

BROWN'S ACCOUNT

Dr.	£ s. d.	Cr.	£ s. d.
Dec. 17 To Crops A/c.	£28 0 0	— By Balance	£28 0 0

RENT ACCOUNT

Dr.	£ s. d.	Cr.	£ s. d.
Jan. 3 To Bank A/c.	150 0 0	— By Profit & Loss A/c. ..	300 0 0
Mar. 30 ,, Landlord's A/c.	150 0 0		
	£300 0 0		£300 0 0

BROMLEY'S ACCOUNT

Dr.	£ s. d.	Cr.	£ s. d.
— To Balance	£33 0 0	Feb. 19 By Imp. A/c.	£33 0 0

WAGES ACCOUNT

Dr.	£ s. d.	Cr.	£ s. d.
Mar. 29 To Bank	£300 0 0	— By Profit & Loss A/c. ..	£300 0 0

GENERAL EXPENSES ACCOUNT

Dr.	£ s. d.	Cr.	£ s. d.
Mar. 29 To Cash	£9 0 0	— By Profit & Loss A/c.	£9 0 0

PROFIT AND LOSS ACCOUNT

Dr.	£ s. d.	Cr.	£ s. d.
— To Implements A/c.	103 0 0	— By Cattle A/c.	1,220 0 0
,, Feeding Stuffs	54 0 0	,, Sheep A/c.	90 0 0
,, Seeds A/c.	26 0 0	,, Crops A/c.	128 0 0
,, Rent A/c.	300 0 0		
,, Wages A/c.	300 0 0		
,, Gen. Expenses	9 0 0		
To Capital A/c. being Net Profit	646 0 0		
	£1,438 0 0		£1,438 0 0

BALANCE SHEET OF ADAM EDEN, 31st MARCH, 1950

LIABILITIES.	£ s. d.	ASSETS.	£ s. d.
— To Sundry Creditors—		— By Cash in Hand	21 0 0
Landlord	150 0 0	,, Cash in Bank	2,490 0 0
Bromley	33 0 0	,, Valuations—	
,, Capital	6,456 0 0	Cattle	2,300 0 0
		Sheep	250 0 0
		Implements	830 0 0
		Crops	500 0 0
		,, Sundry Debtors—	
		J. Dale	100 0 0
		F. Jack	120 0 0
		Brown	28 0 0
	£6,639 0 0		£6,639 0 0

From the particulars seen in Adam Eden's Records it has been possible to prepare a Balance Sheet. The Assets were entered on the right-hand side, and the total of these amounted to £5,850. The total of the Liabilities on the opposite side came to £40. The Assets minus the Liabilities equals the Capital and the £5,850 minus £40 gives the Capital invested in the Farm as £5,810.

The next move was to open the Ledger Accounts, and to bring down the balance of each Account from the Balance Sheet.

The first Balance that is taken down to open an Account is termed the Opening entry.

The Capital Account was the first one to be opened and the Balance of £5,810 was entered on the Credit side.

It is always better to adopt a system in opening the Ledger Accounts and to adhere to it at all times.

One reliable system after opening the Capital Account is to pass over to the Assets and to dispose of them before passing on to the Liabilities.

The Cash Account was opened and £30 was entered in the Debit side.

The Rule when opening the Ledger is to DEBIT EACH ASSET AND TO CREDIT EACH LIABILITY. The complete double entry is made by crediting the Capital Account with the excess of Assets over Liabilities.

A more simple explanation could be found if there were no Liabilities, and all the Capital was in the form of Cash. The £5,810 would be entered on the Credit side of the Capital Account and the £5,810 would be debited to the Cash Account, thus completing the double entry, and conforming to the Rule for opening Ledger Accounts of debiting each Asset and crediting each Liability.

The next Account was the Bank Account and as the Balance was again an Asset, the Account was debited with £1,500.

The Cattle Account was opened and the opening Debit entry was £2,000.

The value of the Sheep, £400, opened the Sheep Account.

£900 was brought down to open the Implement and Machinery Account.

The Crop Account was debited with £800.

John Dale's Account was opened with a Debit Balance of £100.

T. Jack's Account was opened with an entry of £120.

The Asset side of the Balance Sheet was then completed and the total Assets amounted to £5,850.

The opening of the Ledger Accounts was not completed until the Liabilities had been dealt with. The only Liability was in the name of the Landlord, and this Personal Account was opened with a Credit entry of £40.

When the Ledger Accounts were opened the farm transactions for the year were then posted to their respective Accounts in the Ledger.

On the 7th of April, Feeding Stuffs were bought from J. Gray. The Feeding Stuffs Account was debited as they came into the Feeding Stuffs Department, and J. Gray's Account was credited (the Rule is to Credit the giver) with £24.

In the next transaction, Mason's Account was debited with £150 and the Cattle Account was credited, because the Cattle Department gave out this value, and the Rule, as stated earlier, was to credit values given.

The Landlord's Account was debited on June 18th with £40 as he was the Receiver, and the Bank Account was credited as that amount was given by the Bank.

On the 13th of July, the Bank Account was debited with £150 to conform to the Rule, *Debit values Received*, and the Personal Account of M. Mason was credited.

The Bank Account was debited with £240 on August 28th, as the Bank received a cheque valued at that amount for sheep sold. The Sheep Account was credited with the value of the sheep given out by the Shepherd.

The Seeds Department, or Account, received Wheat on September 24th and was debited.

Gray gave or sold the Wheat and his Account was credited with £26.

The Cattle Account was debited with £180 on October 11th for cattle purchased, and the Bank was credited for giving or passing out the money.

The Feeding Stuffs Account, or Department, received £30 worth of Cake on November 28th, and was debited; Gray was credited.

Brown received potatoes and was debited on December 17th with £28, and the Potato Account credited.

The Rent Account was debited with £150 on January 3rd, as the Rule for Nominal Accounts is to Debit Losses. The Bank Account was credited.

The Implement Account was debited on February 19th with the value received, and Bromley's Account was credited with the £33.

On March 26th the Bank was debited with the value of the Cheque received, and the Cattle Account with the amount given, £1,200.

On the 26th of March the Bank was debited and the Crop Account credited £400.

J. Gray's Account was settled on the 28th of March. The Bank Account was credited with the amount that the Bank gave to J. Gray, and Gray's Account was debited with the amount that he received.

On 28th March the Cattle Account was debited with £250, and the Bank Account credited.

The Wages Account was debited with £300 to conform to the Rule that in Nominal Accounts Losses are debited. The Bank Account was credited.

The only cash transaction was paid for General Expenses. The Cash Account was credited with £9 and General Expenses Account, which is another Nominal Account, was debited.

On the 30th of March the half-year's Rent was owing. The Rent Account was debited with £150, as it is a Nominal Account. The Landlord gave the value of the Farm for the half-year, and the Rule in the Personal Account is to Credit the Giver.

It is perhaps a little too early at this stage to say much about the Trial Balance as fuller information on the subject is given later (see page 365), and again the Farmer may not want to trouble about a Trial Balance if he can arrange to balance his Accounts without one.

The point to make at this moment is that the stage is reached when a Trial Balance is drawn up if it is desired. The work is done immediately after the transactions have been posted to the Ledger, and before the Valuations have been entered on the Credit side of the Real Accounts at the end of the year.

An illustration of what takes place is seen in the Trial Balance of Adam Eden.

ADAM EDEN'S TRIAL BALANCE, 31st MARCH, 1950

	Dr.	Cr.
	Totals	
Capital Account		£5,810
Cash	£30	9
Bank	3,490	1,000
Cattle	2,430	1,350
Sheep	400	240
Implements and Machinery	933	
Crops	800	428
J. Dale	100	
F. Jack	120	
Landlord	40	190
Feeding Stuffs	54	
J. Gray		
M. Mason		
Seeds	26	
Brown	28	
Rent	300	
Bromley		33
Wages	300	
General Expenses	9	
	£9,060	£9,060

Closing the Accounts.

When the transactions are all posted to the Ledger Accounts, the valuations at the end of the year are taken to the Real Accounts.

The valuation of Cattle, £2,300, was entered on the right-hand side so as to complete the Account. The same thing happened in the Sheep Account with the £250. Wear and tear seems to have reduced the Implements and Machinery to £830, and the Crops were valued at £500, which was also entered on the credit side.

The Farmer then went to the beginning of the Ledger and closed the first Account, which was the Cash. He saw that there was £30 on the Debit side, and that £9 went out of the Cash Box, leaving a Balance of £21. He entered this Balance on the light side of the Account and so closed the Account for the period.

Since the next day was the beginning of the next Financial year he decided to bring the balance down so that he could see at a glance that he commenced the New Year with £21 in the Cash Box.

The Bank Account showed a total on the Receipt side of £2,490, and as the total sum that had been paid out of the Bank amounted to £1,000, the Balance in hand was £1,490.

The amount of cattle on hand at the beginning of the year plus the purchases reached the figure of £2,430, while the sales of cattle and the value of cattle at the end of the year amounted to £3,650, thereby showing an increase or profit of £1,220. This balance of £1,220 was ear-marked for the Profit and Loss Account.

The £400 worth of sheep showed, through sales and increased value, a profit of £90 which was again taken to the Profit and Loss Account.

Implements, through wear and tear or depreciation, fell £100 in value, and showed a loss of £100.

Crops rose £128, through sales and valuation, and made a profit.

John Dale's Account showed that he still owed the Farmer £100, and the Balance at the end of the year was an Asset.

There was still a debit Balance in F. Jack's Account which was dealt with in the same way as was the previous account.

The Landlord's Account showed that the Farmer owed the Landlord a half-year's Rent and this Balance a Liability was noted for the Final Balance Sheet.

£54 in the Feeding Stuffs Account went to the Profit and Loss Account, as it was a Loss, or Expense, against the Farm.

J. Gray's Account showed that the Farmer purchased Feeding Stuffs, etc., and that the Account was settled.

The same thing applies to the Account of Mason.

The £26 in the Seed Account was shown as a Loss or charge against the Farm.

The Account showed that Brown owed the Farmer for Potatoes, and the Balance ranked as an Asset for the Balance Sheet.

The Rent is always charged as an Expense, or Loss, and of course went to the Profit and Loss Account.

Bromley's Account ranked as a Liability, as the Farmer owed him for an Implement.

Wages are a charge, or loss, to the Farm and were taken to the Profit and Loss Account.

The same procedure applied to the General Expenses Account.

Profit and Loss Account.

The Ledger Accounts were closed and the Farmer was presented with the task of preparing the Profit and Loss Account. This Account, being a Nominal Account, he had to debit all the Losses, and credit all the gains or profits.

The Cattle Account was the first Account to affect the Profit and Loss Account, and, as it showed a Profit, the £1,220 was carried to the Credit side.

The Sheep Account also showed a Profit, and the £90 was taken to the same side of the Profit and Loss Account.

The Implements Account showed a Loss of £103, and this amount was taken to the Debit side of the Profit and Loss Account.

The Profit of £128 on the Crops was credited to the Profit and Loss Account. The £54 in the Feeding Stuffs Account was taken to the Debit side of the Profit and Loss Account.

The Wages and the General Expenses were both taken to the Debit side of the Profit and Loss Account. The Farmer then totalled the Profits or credit side of the Profit and Loss Account and found the sum of £1,438.

On totalling the Losses or Debit side he saw that the losses amounted to £792.

Subtracting the Losses from the Profits, he observed that the Profit, as shown by the Profit and Loss Account, was £646.

If the Capital at the beginning of the year is £5,810, and a Profit is made during the year of £646, the Capital at the end of the year should be £5,810 + £646 = £6,456.

There is, however, a definite procedure in dealing with the Balance in the Profit and Loss Account, and that is to carry it to the Capital Account—in this case to the Credit side of the Capital Account.

The Final Balance Sheet.

Very little remains to be done now apart from preparing the Balance Sheet at the end of the year, and, as shown earlier, it is made up of Assets and Liabilities.

Starting at the beginning of the Ledger it is seen that the Cash Account showed a balance of Cash in hand of £21, which of course is an Asset.

The Bank Account had a balance in hand of £2,490. The Cattle Account showed that the Farmer possessed cattle valued at £2,300.

The Sheep Valuation was £250.

Implements on the Farm amounted to £830.

Crops stood at £500.

J. Dale owed £100.

F. Jack owed £120.

The Farmer owed the Landlord £150, which is a liability.

Brown is a Sundry Debtor and owed £28.

The Farmer owed Bromley £33, and that is another liability.

The Balance Sheet was then totalled.

The Assets amounted to £6,639 and the Liabilities were £183. The excess of Assets over Liabilities was £6,456, which was the Capital invested in the Farm at the end of the year, as shown by the Final Balance Sheet.

There was one more Account to close. By returning to the Capital Account it was seen that the total of the Credit side was £6,456. There were no entries on the Debit side. The Balance of £6,456 was entered and the Account was ruled off.

Several thoughts passed through the Farmer's mind at this juncture. He wondered for one thing if the Accounts were correct, now that they were completed. Relief came, however, when it was discovered that there was an accepted check on the working and arithmetic of the year's Accounting. He was given to understand that if the Capital found in the Final Balance Sheet agreed with the Capital seen in the Capital Account then the accuracy of the work had been proved.

Capital in Cash.

In the previous illustration it was seen that the Farmer's Capital was spread over several Assets. There are cases where a Farmer with £20,000 of Capital might only have £3 in actual cash. There is, of course, the other extreme where the

Farmer has a Capital of £20,000 and it is all in the form of cash.

For example, a Farmer comes into the district to start a Pig Farm with a Capital of £2,000, which is all in the Bank. He purchases, and pays for by cheque, Gilts, Sows, Boars, and Store Pigs for £1,000. Implements and Utensils cost him £200. Feeding Stuffs, also paid for by cheque, amount to £300, Wages £150, Rent £100, and General Expenses £30. He sells pigs during the year for £900. His Valuation at the end of the year shows the Pigs at £1,000, Implements £175, and Feeding Stuffs £25.

CAPITAL ACCOUNT

Dr.	£ s. d.		£ s. d. Cr.
To Balance	2,320 0 0	By Bank A/c.	2,000 0 0
		,, Profit & Loss A/c.	320 0 0
	£2,320 0 0		£2,320 0 0
		,, Balance b/d.	2,320 0 0

BANK ACCOUNT

Dr.	£ s. d.		£ s. d. Cr.
To Capital A/c.	2,000 0 0	By Pigs A/c.	1,000 0 0
,, Pigs A/c.	900 0 0	,, Implements	200 0 0
		,, Feeding Stuffs	300 0 0
		,, Wages	150 0 0
		,, Rent	100 0 0
		,, General Expenses	30 0 0
		,, Balance	1,120 0 0
	£2,900 0 0		£2,900 0 0
To Balance b/d.	£1,120 0 0		

PIGS ACCOUNT

Dr.	£ s. d.		£ s. d. Cr.
To Bank	1,000 0 0	By Bank A/c.	900 0 0
,, Profit & Loss A/c.	900 0 0	,, Valuation	1,000 0 0
	£1,900 0 0		£1,900 0 0
To Balance b/d.	£1,000 0 0		

IMPLEMENTS ACCOUNT

Dr.	£ s. d.		£ s. d. Cr.
To Bank A/c.	200 0 0	By Valuation	175 0 0
		,, Profit & Loss A/c.	25 0 0
	£200 0 0		£200 0 0
To Valuation b/d.	£175 0 0		

FEEDING STUFFS ACCOUNT

Dr.	£ s. d.		£ s. d. Cr.
To Bank A/c.	300 0 0	By Valuation	25 0 0
		,, Profit & Loss A/c.	275 0 0
	£300 0 0		£300 0 0
To Valuation b/d.	£25 0 0		

WAGES ACCOUNT

Dr.			Cr.
To Bank A/c.	£150 0 0	By Profit & Loss A/c.	£150 0 0

RENT ACCOUNT

Dr.			Cr.
To Bank A/c.	£100 0 0	By Profit & Loss A/c.	£100 0 0

GENERAL EXPENSES ACCOUNT

Dr.			Cr.
To Bank A/c.	£30 0 0	By Profit & Loss A/c.	£30 0 0

PROFIT AND LOSS ACCOUNT

Dr.	£ s. d.	Cr.	£ s. d.
To Implements A/c.	25 0 0	By Pigs A/c.	900 0 0
,, Feeding Stuffs	275 0 0		
,, Wages	150 0 0		
,, Rent	100 0 0		
,, General Expenses	30 0 0		
,, Capital A/c., being Net Profit	320 0 0		
	£900 0 0		£900 0 0

BALANCE SHEET

Dr. LIABILITIES.	£ s. d.	Cr. ASSETS.	£ s. d.
To Capital A/c.	2,320 0 0	By Bank A/c.	1,120 0 0
		,, Pigs	1,000 0 0
		,, Implements	175 0 0
		,, Feeding Stuffs	25 0 0
	£2,320 0 0		£2,320 0 0

In making a comparison between the pig farming enterprise and the previous illustration, it will be seen that the Opening Balance Sheet indicated in the one case how the Farmer's Capital was distributed at the beginning of the Financial Year.

The Pig Farmer did not have his Capital spread over various interests. It was in the Bank.

There is a weak point in the Pig Farmer's Accounts. He has his pigs slumped into one Account. A more enterprising venture would have been exhibited if the pigs had been divided into three sections showing the Gilts Account, the Sows Account, and the Store Pigs Account.

A change in the Pig Farmer's Capital is seen at the end of the Year in that it is invested in Pigs, in Implements, in Feeding Stuffs and in the Bank.

Here are explained the chief advantages which are conferred upon the farmer by his Bank. The relationships of farmer to bank are set out and the drawing of cheques and other business details are discussed. This section also includes an elucidation of Discount, Bad Debts and Interest, and shews how a farmer should compute Depreciation. Last of all the Trial Balance is explained and illustrated.

Banking.

The chief advantages to a farmer of keeping a Bank Account are:—

He can pay his debts by bank cheques and so avoid both the risk of keeping large sums of money in the house and also the trouble of counting out and paying cash.

The banker will collect cheques, bills of exchange, etc., paid in, and credit the Farmer's account with the amount.

Bank cheques can be produced as evidence of payment in cases of dispute.

When money is placed on deposit with a bank, it earns interest.

If he is short of money he may, on providing proper security, obtain a loan or overdraft, and he can discount any good bills of exchange which he holds and receive cash for them, less a small charge for discounting.

He may deposit with the bank, for safe custody, such things as valuable documents, deeds, securities, and plate.

The banker will collect and receive monies when due to the Farmer, from his investments, or from pay warrants, and other sources, and dispose of them according to instructions.

He can refer traders to his banker about his financial position, and his banker can make enquiries through other bankers as to the status of his customers.

The business of a bank consists chiefly of:—

Keeping current accounts for customers.
Receiving deposits (payable to the Farmer on demand or at fixed periods). On such deposits interest is allowed.
Discounting and negotiating Bills of Exchange.
Making loans and advances on approved security.
Accepting customers' bills against security.
Issuing drafts, letters of credit, etc.
Acting as agents, trustees, etc.

When a Farmer lodges money with a banker against which he may draw, without notice, by means of cheques, it is said to be on Current Account. When money is placed on Deposit to earn interest, the Farmer receives a Deposit Receipt or Deposit Book, and the money is said to be on *Deposit Account.*

It is the rule with Scottish Banks to pay Deposits on demand, but in England it is the practice to require notice before withdrawal. Unlike Current Accounts, Deposit Accounts cannot be drawn upon by cheques.

When lodging money in the bank, it is necessary to fill up a

PAY-IN SLIP
PAYMENT TO CREDIT OF CURRENT ACCOUNT

Specification of Money	£	s.	d.	Lancaster,.......................... 19..
Bank Notes				Paid to the Credit of
Silver and Copper				
Country Notes				....
Cheques, viz:—				
Own				with the......................Bank, Ltd.
On London				
Country				
Local and P.O.'s				By ....

The classification of the different items facilitates handling and is useful in the prevention of errors.

Pay-in slips are not all alike, each bank has a form of its own, very similar in general outline to the above.

When money is paid in, the bankers retain the slip, and initials the counterfoil, or the bank pass book, as record of payment.

The banker always supplies his customer with a Bank Pass Book, which is a book containing the bank's account with the customer.

Cheques.

A cheque is defined as a Bill of Exchange, and is known in practice as an order upon a banker for the payment of a certain sum of money on demand to, or to the order of, a specified person or to bearer.

When opening a bank account the customer signs the "Signature Book." A banker is bound to know his customers' signatures. If he pays on a forged cheque, the loss falls on him. If it can be shown, however, that, through carelessness, the customer has given an opportunity

for forgery, the banker may not be held liable.

Bankers supply two forms of cheques—" To Order," and " To Bearer."

These are bound in Cheque Books. Each cheque costs twopence for the impressed stamp thereon. Cheque books are only supplied on signed order or personal application of the customers and should be kept under lock.

When the cheque is filled up it is torn off where perforated, leaving the counterfoil with the particulars briefly entered for reference.

An *Order Cheque* is one payable to a specified person, or to such person as the payee may order to receive the money.

FORM OF ORDER CHEQUE (Stamp Duty, 2d.)

Counterfoil	
No. B.12	No. B.12
1st Dec., 19....	Perth, 1st Dec., 19 ....
	The National Bank, Ltd., Perth
J. Brown	Pay to John Brown .... or order
	Ten Pounds Five Shillings and Sixpence
	Jack Fry
£10 5s. 6d.	£10 5s. 6d.

A *Bearer Cheque* is one payable to a specified person, or to bearer, without endorsement.

The parties to a cheque are:—

Drawer—the person who signs the cheque.
Drawee—the banker on whom it is drawn.
Payee—the person to whom the amount is payable.

In the foregoing cheque, Fry—the drawer—is directing the National Bank Ltd., Perth—the drawees—to pay John Brown—the payee—or order £10 5s. 6d. out of his (Fry's account at the) bank.

A cheque must be signed by the drawer, dated, the name of payee inserted, and the amount must be stated in words as well as figures.

In writing a cheque begin as near the left-hand margin as possible to prevent the insertion of any larger amount. The cheque should be written by the customer or by someone authorised by him.

The date should be that on which it is drawn, although a cheque can be ante-dated, post-dated, or dated on a Sunday.

A post-dated cheque would not be paid by a banker until the date it bears.

The receiver of an undated cheque may insert the date he thinks true.

Endorsement:—To Endorse is to sign one's name across the back of the cheque. A cheque payable " To Bearer " is payable, without endorsement, to any one presenting it at the bank, but the banker may ask for endorsement as evidence of identity. A cheque payable " To Order " must always be endorsed by the payee before it can be negotiated or cashed.

A cheque payable to John Brown or order would be endorsed:—

John Brown.

This is termed a " General " or " Blank " endorsement. The endorsement must always agree with the name or names mentioned in the cheque. If the above cheque was received with the name wrongly spelled, " Browne," it would require to be endorsed thus:—

John Browne
John Brown.

If, instead of banking the cheque, Brown, the payee, wished to pay it over to another person—e.g., A. Bell—he would endorse as follows:—

Pay A. Bell or order
John Brown.

In this event the new endorsee, A. Bell, must himself endorse the cheque before he parts with it.

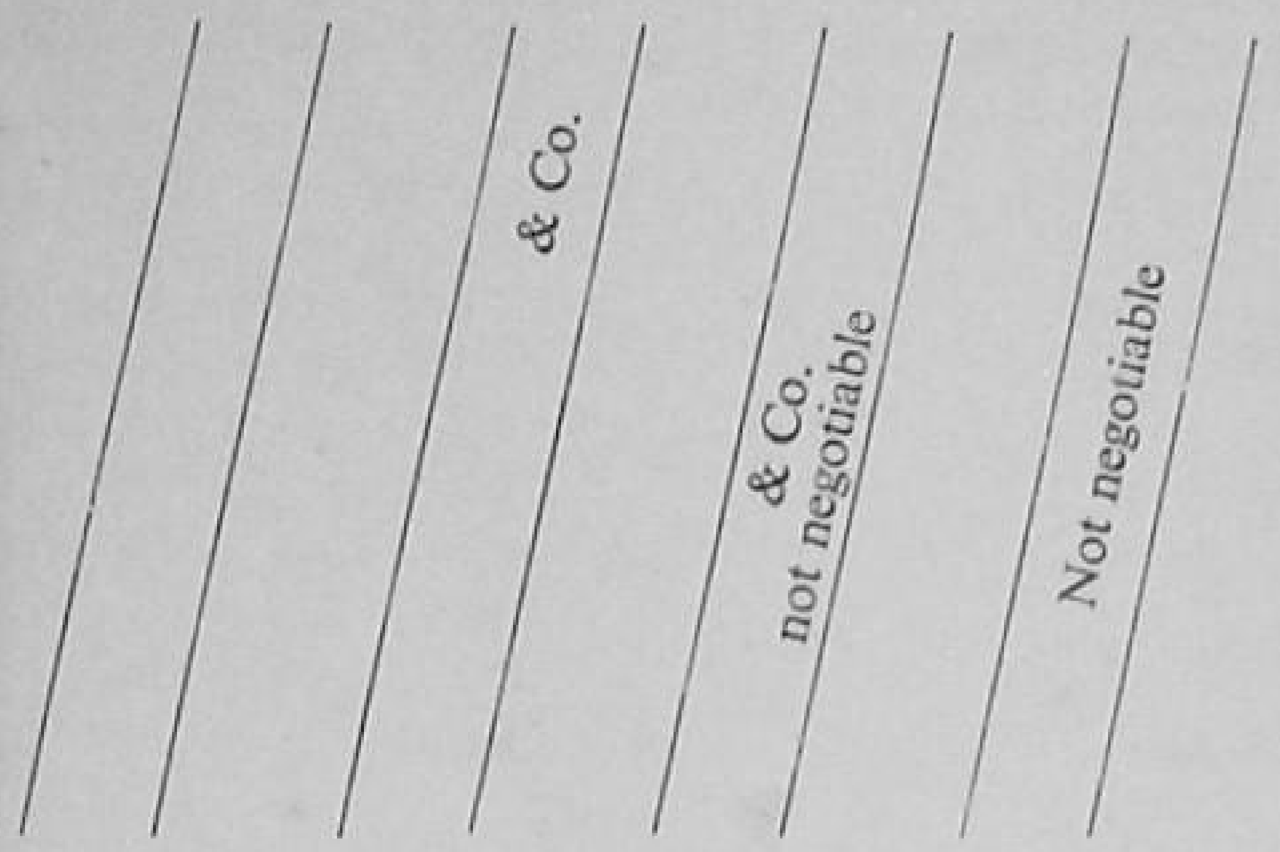
This is termed a " Special " endorsement. Pay " A. Bell only " is a " Restrictive " endorsement, and prevents further negotiations, i.e., A. Bell cannot transfer the cheque to anyone except his banker for collection. Restrictive endorsements, it may be said, are seldom met with in practice.

Crossings:—When a Cheque is not crossed it is called an Open Cheque, and cash can be obtained for it from the banker on whom it is drawn.

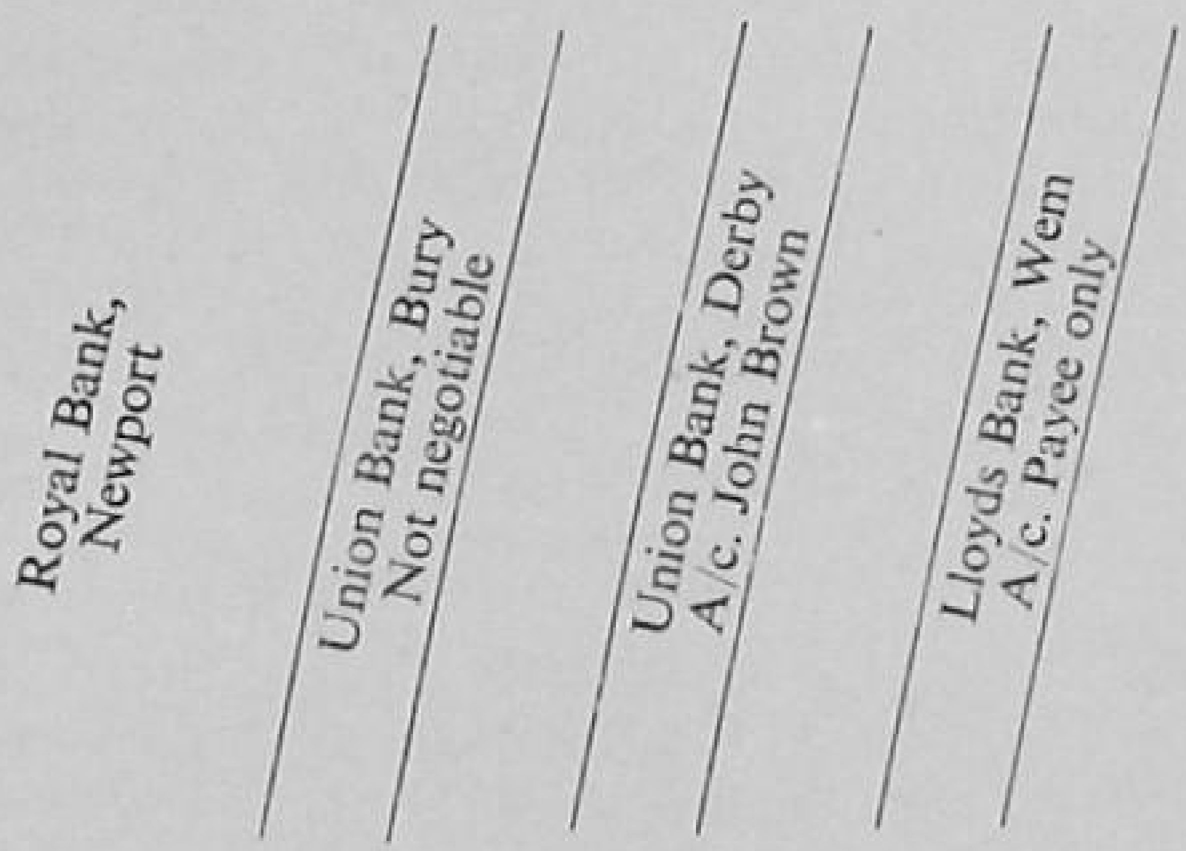
In practice nearly all cheques are crossed as a protection against fraud should they go astray.

When a cheque is crossed the banker will not pay cash over the counter. It will only be paid to another banker. A person receiving a crossed cheque must, therefore, hand it to his banker, who will collect it for him and place the amount to the credit of his account. If he has no bank account, he should give it for collection to some friend who has one, because bankers, as a rule, only collect for customers.

A cheque is crossed "Generally" when two parallel transverse lines are drawn across the face of the cheque, either with or without the words "& Co.", "Not Negotiable," etc.



A cheque is crossed "Specially" when the name of a bank is written across, with or without parallel lines.



The words "Not Negotiable" without the lines or the name of a bank, do not constitute a crossing.

When a cheque is crossed "Specially," the banker on whom it is drawn must pay it only to the banker with whose name it is crossed. If a cheque, for example, is drawn on Cox's Bank, Leek, and crossed Union Bank, London, you are directing your bankers, Cox's Bank, Leek, to pay the cheque through the Union Bank, London.

The words "A/c. John Brown," or "A/c. Payee only," written on a cheque is a direction to the collecting bank to credit a particular account.

The Bills of Exchange Act, however, does not recognize these words as part of the crossing.

Although these words have no statutory sanction, the collecting banker should observe the crossing, otherwise he might be liable for any irregularity.

Negotiability:—A cheque is a negotiable instrument, and if accepted by a person in exchange for value given, and in good faith, it becomes his property, and his title to it cannot be disputed provided there is no previous forgery on it.

When a cheque, however, is crossed "Not Negotiable," it ceases to be negotiable, although it can still be transferred subject to certain legal restrictions.

In technical language, "Not Negotiable" on a cheque means that "where a person takes such a cheque he shall not have, and shall not be capable of giving, a better title to the cheque than that which the person from whom he took it had." Where a person takes a crossed cheque marked "Not Negotiable," he takes it subject to all defects in the title of the person who gave it to him, even although he has no knowledge that there is anything wrong.

If there is any irregularity of title, the holder of such a cheque would lose the money, because the drawer can refuse to honour it.

Payment of a cheque may be stopped by instruction from the drawer to his banker.

Cheques are sometimes Dishonoured, i.e., returned by the banker unpaid, for various reasons, viz.:—

Notice of the drawer's death.
Knowledge of bankruptcy of the drawer.
A Garnishee order arresting his funds at the bank. (A Garnishee order is the term in in England. In Scotland it is termed "Arrestment").
No funds, or insufficient funds, at the customer's credit.
When the words and figures on the cheque differ; also irregularities of endorsement or signature. (Note.—Alterations on cheques should be initialled by the drawer.)

Slips are attached by the bankers to returned cheques and marked as follows:—

N/S or I/F—Means "Not sufficient funds."
N/F—Means "No funds."
R/D—Means "Refer to drawer." Generally another way of saying "No funds."
"Not in order"—Means there is some error or omission in the cheque, such as a difference between figures and writing.
"Endorsement irregular"—Means some irregularlity or omission in endorsement.
"Effects not cleared"—Means that cheques, etc., lodged have not yet been credited to the account, as it usually takes a day or two to "clear" cheques, i.e., to pass through the Clearing-House.

A Stale Cheque is one which the holder has delayed in presenting. Some banks will not cash a cheque six months old unless verified by the drawer.

When a cheque is presented to a banker in England for a sum in excess of the amount at the customer's credit, the banker may return it marked N/S, "Not sufficient funds," but a banker can still pay other smaller cheques not

exceeding the amount at the credit of the customer.

The law in Scotland is different. A person in Scotland with, say, £50 at his credit may issue a cheque for £70, and find it dishonoured should the banker decline to allow the customer to overdraw; but the presentment of the cheque, in these circumstances, establishes a lien on the £50 in favour of the holder of the cheque, or, in other words, acts as an arrestment of the £50.

Payments to and drawings upon Current Account are taken to be set off against each other chronologically, the earliest drawing against the earliest payment, and so on.

The banker may treat all a customer's personal accounts as one, but may not use the balance of an account as to which he has notice that it is not a personal account, to meet a deficiency on a personal account.

The Bank Account and the Cash Account are the two Ledger Accounts that receive and expend all monies relating to the transactions throughout the year. There is, however, a sound suggestion that all the Farm money transactions should be made through the Bank. This suggestion would simplify the work as it would prevent the Cash and Bank transaction from being mixed.

In practice, however, it is usually advisable to pay small amounts such as market expenses, postages, hay rakes, brushes and small tools out of cash. This is done by drawing a sum of money, say £40, from the Bank, and placing it in the Cash Box. If the Farmer pays £10 for Market expenses, £5 for miscellaneous tools, and £1 for Stamps, the transactions would be entered in the Cash Account.

CASH ACCOUNT

Dr.			Cr.
To Bank A/c.	£40	By General Expenses A/c.	£10
		,, General Expenses A/c.	5
		,, General Expenses A/c.	1

BANK ACCOUNT

Dr.			Cr.
		By Cash A/c.	£40

In the first transaction the Cash Box or Book was debited with £40 as it received that amount, and the Bank Account was credited.

The cash transactions were all credited in the Cash Book as the Cash Box gave out the money for brushes, stamps and market expenses.

The General Expenses Account would be debited to complete the entries.

The farmer's difficulty of visiting the Bank is perhaps another good reason for keeping a Cash Account.

The City business man probably pays cheques into the Bank twice per day. The farmer may only visit the City twice in a month.

When the farmer receives a cheque he perhaps places it carefully away in his pocket book. It should, however, be locked safely in the Cash Box.

Supposing the farmer received a cheque for £250 from Brown on 27th March, it would be wrong to debit the Bank and credit Brown, as the cheque would be in the Cash Box. The correct entry therefore would be to debit the Cash Account and to credit Brown.

CASH ACCOUNT

Dr.			Cr.
Mar. 27 To Brown	£250		

By BROWN'S ACCOUNT

Dr.			Cr.
		Mar. 27 By Cash A/c.	£250

When the farmer pays the cheque into the Bank he will debit the Bank Account and credit the Cash Account. This he did on the 7th of April.

BANK ACCOUNT

Dr.			Cr.
April 7 To Cash A/c.	£250		

CASH ACCOUNT

Dr.			Cr.
		April 7 By Cash A/c.	£250

The Cash Account would then have nothing in it.

CASH ACCOUNT

Dr.			Cr.
Mar. 27 To Brown's A/c.	£250	Apr. 7 By Bank	£250

In cases where all the accounts are paid by cheque, and all the cheques paid into the Bank, the following transactions would appear in the Bank Account as such:—

Paid Feeding Stuffs Account by Cheque ..	£40
Handed the Auctioneer Cheque for Cattle ..	£500
Paid Rent by Cheque	250
Bought Tractor and paid by Cheque	475
Received Cheque for Cows	250
Sold Two Horses and received Cheque ..	230
The Factory paid Cheque for Sugar Beet ..	190

BANK ACCOUNT

Dr.			Cr.
To Cows A/c.	£250	By Feeding Stuffs	£400
,, Horses A/c.	230	,, Auctioneer A/c.	500
,, Sugar Beet A/c.	190	,, Rent A/c.	250
		,, Implements A/c.	475

DISCOUNT.

Cash Discount and Trade Discount.

Cash Discount is an allowance made for the prompt payment of an account, or for payment within a certain stipulated date.

A farmer purchases Feeding Stuffs from J. Walls at £50. The Feeding Stuffs Account is debited and J. Walls' Account credited with £50.

A farmer pays by cheque and is allowed £2/10/– discount. J. Walls' Account is debited and the Bank is credited with £47/10/–. Now J. Walls' Account shows that he has still to receive £2/10–. This is not the case, as the Account is settled, and at the time of settlement a discount of £2/10/– was allowed. The procedure now is to close J. Walls' Account by debiting it with £2/10/– and by crediting the Discount Account with £2/10/–.

FEEDING STUFFS ACCOUNT

Dr.			Cr.
To Walls' A/c.	£50		

J. WALLS' ACCOUNT

Dr.			Cr.
To Bank A/c.	£47 10	By Feeding Stuffs	£50
,, Discount A/c.	2 10		
	£50 0		£50

DISCOUNT ACCOUNT

Cr.			Dr.
To Profit & Loss A/c.	£2 10	By J. Wall's A/c.	£2 10

Bought artificial manures from Cross & Co., £100, and settled the Account one month later by cheque, less 2½ per cent. discount. The Artificial Manures Account is debtor to Cross & Co.'s Account.

ARTIFICIAL MANURES ACCOUNT

Dr.			Cr.
To Cross & Co.	£100		

CROSS & CO.

Dr.			Cr.
To Bank A/c.	£97 10	By Artificial Manures A/c.	£100
,, Discount	2 10		
	£100 0		£100

When the payment is made, Cross' Account is debtor to the Bank Account. Cross' Account receives £97/10/– and the rule is to debit the Receiver. To balance Cross' Account it will be necessary to show the Discount.

DISCOUNT ACCOUNT

Dr.			Cr.
To Profit & Loss A/c.	£2 10	By Cross' A/c.	£2 10

Sold cow to James Robb for £120.

ROBBS' ACCOUNT

Dr.			Cr.
To Cow A/c.	£120	By Bank A/c.	£110
		,, Discount	10
	£120		£120

COW ACCOUNT

Dr.			Cr.
		By Robb's A/c.	£120

Received cheque from Robb. Allowed him £10 discount.

Debit the Bank Account with £110 and credit Robb's Account with £110. Close Robb's Account by crediting it with £10 and debiting the Discount Account.

DISCOUNT ACCOUNT

Dr.			Cr.
To Robb's A/c.	£10	By Profit & Loss A/c.	£10

The Bank Account would contain the following entries.

BANK ACCOUNT

Dr.			Cr.
To James Robb's A/c.	£110	By J. Walls' A/c.	£47 10
		,, Cross & Co.	97 10

Only one Discount Account would be shown in the ledger and it would have three entries.

DISCOUNT ACCOUNT

Dr.			Cr.
To Robb's A/c.	£10 0	By J. Walls' A/c.	£2 10
		,, Cross & Co.	2 10
		,, Profit & Loss A/c.	5 0
	£10 0		£10 0

Trade Discount is a discount that is allowed to people in the trade. It is an allowance made to wholesale buyers who sell the goods over again, and it is deducted from the Invoice. The rate varies in the different trades.

Bad Debts.

When a person becomes bankrupt and is unable to pay his Account, the person to whom he owes money has incurred a bad debt. If the bankruptcy is a bad one, that is, where the Liabilities far exceed the Assets, there may be no receipts or only a few shillings in the pound.

When a debt in a farmer's books is known to be bad, it should be written off and transferred to a Bad Debts Accounts in the ledger, otherwise the books would not show a record of what has actually occurred. The Bad Debts Account is debited and the Debtors' Account is credited.

The farmer sells four cows to S. Murphy for £200. Murphy's Account is debited and the Cows Account is credited with £200.

S. MURPHY'S ACCOUNT

Dr.			Cr.
To Cows A/c.	£200	By Bank A/c.	£100
		,, Bad Debts A/c.	100
	£200		£200

COWS ACCOUNT

			Cr.
		By S. Murphy's A/c.	£200

Murphy fails and pays a final dividend of 10/– in the £.

The Bank Account is debited with £100 and Murphy's Account credited with £100.

Murphy's Account shows that he still owes £100, but since the dividend is final his account must be closed to Bad Debts Account. The Bad Debts Account is debited and Murphy's Account credited with £100.

BAD DEBTS ACCOUNT

Dr.			
To Murphy's A/c.	£100	By Profit & Loss A/c.	£100

The Balance of the Bad Debts Account is transferred to the Profit and Loss Account at the end of the year.

Interest.

Interest is the premium paid by a borrower for the loan of money. The interest is termed Simple Interest when it is the amount calculated upon the original sum advanced.

Interest paid or due by the farmer is a loss to the farm and is debited to the Interest Account. Interest received or owing to the farmer is a gain to the farm and is credited to the Interest Account.

Lent P. Marsh £1,000 at 3 per cent. Interest.

P. MARSH'S ACCOUNT

To Bank	£1,000		

Received Interest from P. Marsh, £30.

The Bank Account is debited and the Interest Account is credited. Notice that Marsh's Account is not affected, and that the original loan remains in his Account.

INTEREST ACCOUNT

		By Bank	£30

Lent J. Bull £500 at 3% Interest. Debit Bull, and Credit Bank.

J. BULL'S ACCOUNT

Dr.			Cr.
To Bank A/c.	£500		
,, Interest A/c.	15		

Interest on J. Bull's Account is now due, £15. Debit Bull's Account and credit Interest Account.

J. Bull's Account now shows that he owes £515.

INTEREST ACCOUNT

		By J. Bull's A/c.	£15

J. Bull pays the Interest due, £15. Debit Bank Account and credit J. Bull's Account.

J. Bull's Account shows that the original loan of £500 is standing in his Account.

J. BULL'S ACCOUNT

To Bank	£500	By Bank A/c.	£15
,, Interest A/c.	15		

Arranged Loan from B. Whyte for £600 at 3 per cent., and received a cheque.

B. WHYTE'S ACCOUNT

Dr.			Cr.
		By Bank A/c.	£600

Paid Interest on this Loan. Debit the Interest Account and Credit Bank Account.

INTEREST ACCOUNT

To Bank	£18	To Profit & Loss A/c.	£18

Eighteen months later a half-year's Interest is due on Whyte's Loan.

Debit the Interest Account and Credit Whyte's Account.

INTEREST ACCOUNT

To Whyte's A/c.	£9		

WHYTE'S ACCOUNT

		By Bank	£600
		,, Interest A/c.	9

Whyte's Account shows that the amount due to him is the original loan plus the Interest.

There would be only one Interest Account for all the above transactions.

INTEREST ACCOUNT

To Bank	£18	By Bank	£30
,, Whyte's A/c.	9	,, Bull's A/c.	15
,, Profit & Loss A/c.	18		
	£45		£45

BANK ACCOUNT

To Interest A/c.	£30	By P. Marsh's A/c.	£1,000
,, J. Bull's A/c.	15	,, J. Bull's A/c.	500
,, B. Whyte's A/c.	600	,, Interest A/c.	18

At this stage of the work the Profit and Loss Account would contain several items additional to those seen in Adam Eden's ledger.

PROFIT AND LOSS ACCOUNT

Dr.			Cr.
Rent	£300	Cattle	£40
Wages	320	Sheep	50
General Expenses	100	Oats	75
Feeding Stuffs	250	Barley	700
Seeds	70	Milk	1,000
Depreciation	60		
Discount	10		
Bad Debts	75		
Interest	10		
To Capital A/c., being Net Profit	670		
	£1,865		£1,865

Depreciation.

Farm accounts would be most irregular if some consistent system of Depreciation were not adhered to. There would be a tendency for Capital, Profits and Losses to fluctuate probably at a time when the factors causing such fluctuations did not exist.

Depreciation may be defined as the amount of fall in value of machinery, property, leases and other fixed assets through wear and tear, obsolescence, effluxion of time, and other causes.

The main object of writing off depreciation is to spread the cost of wasting assets over the period of their effective life. Depreciation must not be confused with fluctuation in value. Fixed assets are held for use, not for sale, and fluctuation of fixed assets does not, in ordinary circumstances, affect their earning capacity.

It is rather a difficult matter to estimate or fix upon a scale of depreciation that will meet with the requirements of every contingency.

Apart from natural wear and tear, the risk of implements and other similar assets becoming obsolete, before being worn out, may require to be taken into account.

A farmer may to-day buy a new machine, and in a year or two find it superseded by an improved pattern. Its immediate replacement may be imperative if its retention in use handicaps the farmer in good husbandry. He may, therefore, be forced to write off and discard prematurely an asset which, in ordinary circumstances, might be expected to perform its work efficiently for years.

Ordinarily, in estimating the amount of depreciation to be written off annually, the factors to be considered are cost, probable working life, maintenance required and residual value, if any.

Depreciation of fixed assets, such as plant and buildings, is generally effected by writing off a certain percentage yearly. The method and rate of writing down varies according to the nature of the asset, and should be decided upon by someone possessing practical knowledge of the property to be depreciated.

Fixed Instalment Method.

Depreciation may be written off by a certain number of equal annual instalments, usually a fixed percentage on the original cost of the asset.

Machinery costing, say, £500, and estimated to have a life of 10 years, may be written down by one-tenth per annum on the original cost (i.e., £50 each year), so that when discarded at the end of 10 years, the book value would be nil.

Reducing Instalment Method.

Depreciation may be written off by a fixed rate per cent. on the diminishing value.

If the rate of depreciation by the Reducing Instalment System is fixed at 10 per cent. per annum, the depreciation on implements costing £500 would be £50 at the end of the first year, but at the end of the second year the depreciation would only be £45, thus:—

Implements	£500 0 0	
Less 10%	50 0 0	1st year
	£450 0 0	
Less 10% on £450	45 0 0	2nd year
	£405 0 0	
Less 10% on £405	40 10 0	3rd year
	£364 10 0	

and so on.

When this method is adopted, the amount of depreciation charged to Profit and Loss becomes less year by year until, at the end of the tenth year, the amount is about £19, as against £50 in the first year, but it should be noted that there would be a balance at the debit of Machinery Account of £175 still to be extinguished.

Where the depreciation is a fixed annual charge of 10 per cent on the original cost, the asset would be completely written off in ten years; whereas if, on £500, the percentage written off the diminishing balance be 15 per cent. per annum, the residue remaining at the end of ten years would be £98. In fact there will always be a balance under the Reducing Instalment System.

It is thus clear that in order to obtain the same approximate result the rate per cent. under the Reducing Instalment System must be considerably higher than under the Fixed Instalment System.

As a set-off, however, the disparity between the two methods, it should be borne in mind that whilst the annual charge for depreciation by the Reducing Instalment System grows less year by year, the cost of upkeep and repairs is invariably increased as the asset becomes older. The later years, therefore, although charged less for depreciation, are bearing heavier expenses for maintenance.

The amount written off for depreciation is debited to Profit and Loss Account and credited to the Asset Account. The Accounts in the Ledger would appear in this way:—

IMPLEMENTS ACCOUNTS

Dr.			Cr.
To Valuation	£500	By Depreciation	£50
		„ Valuation	450
	£500		£500
To Valuation Brought Down	£450		

DEPRECIATION ACCOUNT

To Implements A/c.	£50	By Profit & Loss A/c.	£50

The £450 Balance in the Implements Account would also appear at the end of the year in the Balance Sheet.

The Implements Account in the Ledger would start the next year with a debit Balance of £450.

IMPLEMENTS ACCOUNT

To Valuation	£450	By Depreciation	£45
		,, Valuation	405
	£450		£450

DEPRECIATION ACCOUNT

To Implements	£45	By Profit & Loss A/c.	£45

The Implements would now appear in the Balance Sheet at the end of the year as an Asset valued at £405.

IMPLEMENTS ACCOUNT

To Valuation	£405	By Depreciation A/c.	£40 10
		,, Valuation	364 10
	£405		£405 0

DEPRECIATION ACCOUNT

To Implements A/c.	£40 10	By Profit & Loss A/c.	£40 10

The Trial Balance.

The Trial Balance is a list of the balances in a Ledger on any given date. The balances of Bank, Cash and Petty Cash must, of course, be included as they are strictly ledger account balances. The debit balances are entered in one column and the credit balances in another. If the books have been correctly entered and posted, the totals of the two columns must agree because for every debit entry there has been a corresponding credit entry.

A Trial Balance may be extracted at any time to prove the arithmetical accuracy of the accounting. In practice, a Trial Balance is in many cases extracted at the end of each month, and in all cases, before closing the books at the end of the financial period, usually a year.

A Trial Balance is not an account, but simply a list of balances; therefore, it is not usually written in one of the books but on separate sheets.

When on the extraction of a Trial Balance, the total of the debit balances equals the total of the credit balances it may, as a rule, be taken that the books are arithmetically correct, but it does not conclusively prove the accuracy of the recording.

There are certain errors which a Trial Balance does not disclose.

(*a*) Errors in original entries; for example, a sale of a calf, £10, entered in the sheep account as 10/–.

(*b*) The correct amount posted to the wrong account; for example, a Dr. entry posted to James & Co., instead of John & Co., or a Cr. entry posted to R. Jamieson instead of R. Johnson. Vital errors of principle may remain undisclosed by a Trial Balance, such as posting an item of Expenses (an expense, therefore a Nominal Account), to a Real Account, for example, posting a payment for Repairs to Implement Account instead of to Repairs Account.

(*c*) Compensating Errors; for example, posting £10 to the debit of A. Casey instead of £1, and posting £20 to the debit of G. Richards, instead of £29.

(*d*) The complete omission of a transaction from the books.

When the Dr. and Cr. totals of a Trial Balance do not agree, the following procedure should be adopted to locate the differences:—

1. Check the additions of the Trial Balance.
2. Check the extraction of the balances so as to ensure that no error has occurred and that no balances have been omitted.
3. Check the additions in the Ledger Accounts, Cash, Bank, etc.

Sometimes an error may be quickly located by noting the difference between the Trial Balance

totals. Suppose the Cr. side is £10 greater than the Dr. side, this might be accounted for by placing an item of £5 (half the amount) in the wrong column of the Trial Balance, or by posting an item to the wrong side of the Ledger. For example, Discount £5, posted in error to the credit of Discount Account instead of to the debit, would, if noticed, promptly reveal the difference. It is therefore desirable as a preliminary step, to spend a little time in scrutinising the individual items in the books as well as in the Trial Balance.

Accounts which are square in the Ledger should be passed over, and not included in the Trial Balance, which is an extract of the Balances only.

Always prepare the Trial Balance before the Valuations are entered on the credit side of the Real Accounts at the end of the year.

By referring back to the Trial Balance of Adam Eden, it will be seen that it is made up of Total Debits and Total Credits.

The most common procedure is to enter the Balance, which is the difference between the debit and credit sides of each account.

TRIAL BALANCE OF ADAM EDEN,

31st MARCH, 1950

	Totals Dr.	Totals Cr.	Balances Dr.	Balances Cr.
Capital Account ..		£5810		£5810
Cash	£30	9	£21	
Bank	3490	1000	2490	
Cattle	2430	1350	1080	
Sheep	400	240	160	
Imp. and Mach. ..	933		933	
Crops	800	428	372	
J. Dale	100		100	
P. Jack	120		120	
Landlord	40	190		150
Feeding Stuffs ..	54		54	
J. Gray				
M. Mason				
Seeds	26		26	
Brown	28		28	
Rent	300		300	
Bromley		33		3
Wages	300		300	
General Expenses ..	9		9	
	£9060	£9060	£5993	£5993

This section begins with a complete set of Ledger Accounts to shew how the items dealt with in the latter part of Section II are treated in a list of transactions. Next the questions involved in the close relationship subsisting between a farmer's business and his domestic life are dealt with in a section entitled "Private Life." The subject of Partnership Accounts receives attention. Then follow sections on The Trading Account, Owner and Occupier's Account, The Cash Book, Purchase Book, Sales Book and Petty Cash Book, The Diary and The Journal, with all of which the author deals in a manner which should be of service to both student and farmer. The section concludes with a useful glossary of Terms used in Business.

Complete Set of Ledger Accounts.

Since Depreciation, Discount, Bad Debts, and Private Receipts and Payments have been written in their respective accounts, it might be advantageous to complete a set of Ledger Accounts to show how these items are treated in a list of transactions.

From the following particulars it is necessary to write up the Ledger and to prepare a Profit and Loss Account and Balance Sheet for A. Chesher, Keir Farm, Newport.

On September 29th, 1948, he had cash in hand £40, and in the Bank £960. His Valuation showed Corn, Hay and Straw at £600, Implements £480, Growing Crops £260, Horses £200, Cattle £400, Pigs £15. He owed J. Crowe £50, F. Dunn owed him £20, and S. Farr owed him £30.

His transactions for the year were as follows:—

Date		Particulars	£	s.	d.
1948					
Oct.	13	He sold Seed Oats to G. Howes	£360	0	0
Dec.	24	Bought from R. Walls, Feeding Stuffs	90	0	0
1949					
Feb.	28	Sold Wheat to M. Tapley for cash	£380	0	0
Mar.	3	Received cheque from G. Howes	360	0	0
,,	7	Paid cash into bank	740	0	0
,,	25	Handed cheque to A. Black on loan	100	0	0
,,	29	Bought Seeds from A. Clucas..	28	0	0
Apr.	4	Paid half-year's rent by cheque	130	0	0
July	23	Sold cattle and received cheque	360	0	0
,,	27	Sold milk and eggs for cash ..	70	0	0
Aug.	2	Bought Horse and paid cheque	80	0	0
,,	2	Paid General Expenses ..	10	0	0
,,	2	Paid Clucas by cheque ..	26	12	0
,,	2	Was allowed Discount ..	1	8	0
,,	26	Sold Cattle and received cheque	200	0	0
,,	27	Purchased Cattle and paid cheque	280	0	0
Sept.	1	Paid cash into bank	600	0	0
,,	1	Paid Private Expenses cash ..	50	0	0
,,	13	Paid R. Walls by cheque ..	85	10	0
		He allowed Discount ..	4	10	0
,,	24	Sold Wheat to M. Tapley ..	330	0	0
,,	25	Bought Cattle and paid cheque	500	0	0
,,	25	Half-year's interest due from A. Black	1	10	0
,,	26	Sold Cattle to B. Dealer ..	370	0	0
,,	28	Paid cheque for Insurance ..	20	0	0
,,	28	Drew cash for wages during year	750	0	0
,,	29	A. Black failed and paid a final dividend of 10/- in the £ and paid cheque into bank ..	50	15	0
,,	29	Half-year's rent due	130	0	0

Allow 15 per cent for depreciation of Implements.

Valuations:		
	Corn, Hay and Straw ..	£860
	Growing Crops ..	£340
	Cattle	£460
	Pigs	£20
	Horses	£280

BALANCE SHEET OF A. CHESHER, KEIR FARM
29th SEPTEMBER, 1948

Dr.					Cr.			
1949	LIABILITIES.	£	s.	d.	1949	ASSETS.	£	s.	d.
—	To Sundry Creditors:				—	By Cash in hand	40	0	0
	J. Crowe	50	0	0		,, Cash in bank	960	0	0
	Capital	2,955	0	0		,, Valuations:			
						Corn, Hay and Straw ..	600	0	0
						Implements	480	0	0
						Growing Crops	260	0	0
						Horses	200	0	0
						Cattle	400	0	0
						Pigs	15	0	0
						,, Sundry Debtors:			
						F. Dunn	20	0	0
						S. Farr	30	0	0
		£3,005	0	0			£3,005	0	0

CAPITAL ACCOUNT

Dr.						Cr.			
1949		£	s.	d.	1948		£	s.	d.
Sept. 29	To Private A/c.	50	0	0	Sept. 29	By Balance	2,955	0	0
,, 29	,, Balance	3,326	13	0	1949				
					Sept. 29	,, Profit & Loss A/c. ..	421	13	0
		£3,376	13	0			£3,376	13	0

PRIVATE ACCOUNT

Dr.		£ s. d.			Cr. £ s. d.
1949			1949		
Sept. 1	To Cash A/c.	50 0 0	Sept. 29	By Capital A/c.	50 0 0

CASH ACCOUNT

Dr.		£ s. d.			Cr. £ s. d.
1948.			1949		
Sept. 29	To Balance	40 0 0	Mar. 7	By Bank A/c.	740 0
1949.			Aug. 2	,, General Expenses ..	10 0
Feb. 28	,, Corn, Hay & Straw A/c...	380 0 0	Sept. 1	,, Private Expenses	50 0
Mar. 3	,, G. Howe's A/c. ..	360 0 0	Sept. 1	,, Bank A/c.	600 0
July 23	,, Cattle A/c.	360 0 0	1949.		
July 27	,, Milk & Eggs A/c. ..	70 0 0	Sept. 29	,, Balance	10 0
Aug. 26	,, Cattle A/c.	200 0 0			
		£1,410 0 0			£1,410 0

BANK ACCOUNT

Dr.		£ s. d.			Cr. £ s. d.
1948			1949		
Sept. 29	To Balance	960 0 0	April 4	By Rent A/c.	130 0
1949			Mar. 25	,, A. Black's A/c.	100 0
Mar. 7	,, Cash A/c.	740 0 0	Aug. 2	,, Horses A/c.	80 0
Sept. 1	,, Cash A/c.	600 0 0	Aug. 2	,, J. Clucas' A/c.	26 12
Sept. 29	,, A. Black's A/c.	50 15 0	Aug. 27	,, Cattle A/c.	280 0
			Sept. 13	,, R. Walls' A/c.	85 10
			Sept. 25	,, Cattle A/c.	500 0
			Sept. 28	,, Insurance A/c.	20 0
			1949		
			Sept. 29	,, Wages	750 0
				,, Balance	378 13
		£2,350 15 0			£2,350 15

CORN, HAY AND STRAW ACCOUNT

Dr.		£ s. d.			Cr. £ s. d.
1948.			1948		
Sept. 29	To Valuation	600 0 0	Oct. 13	By G. Howes' A/c.	360 0
			1949.		
			Feb. 28	,, Cash A/c.	380 0
1949.			Sept. 24	,, M. Tapley A/c.	330 0
Sept. 29	To Profit & Loss A/c. ..	1,330 0 0	1949		
			Sept. 29	,, Valuation	860 0
		£1,930 0 0			£1,930 0

IMPLEMENTS ACCOUNT

Dr.		£ s. d.			Cr. £ s. d.
1948			1949		
Sept. 29	To Valuation	480 0 0	Sept. 29	By Depreciation	72 0
			Sept. 24	By Valuation	408 0
		£480 0 0			£480 0

GROWING CROPS ACCOUNT

Dr.		£ s. d.			Cr. £ s. d.
1948			1949		
Sept. 29	To Valuation	260 0 0	Sept. 29	By Valuation	340 0
1949.					
Sept. 29	,, Profit & Loss A/c. ..	80 0 0			
		£340 0 0			£340 0

HORSES ACCOUNT

Dr.		£ s. d.			Cr. £ s. d.
1948			1949.		
Sept. 29	To Valuation	200 0 0	Sept. 29	By Valuation	280 0
1949.					
Aug. 2	,, Bank A/c.	80 0 0			
		£280 0 0			£280 0

CATTLE ACCOUNT

Dr.	£ s. d.		Cr. £ s. d.
Sept. 29 To Valuation ..	400 0 0	July 23 By Cash A/c.	360 0 0
1949.		Aug. 26 ,, Cash A/c.	200 0 0
Aug. 27 ,, Bank A/c.	280 0 0	Sept. 26 ,, B. Dealer A/c.	370 0 0
Sept. 25 .. Bank A/c.	500 0 0	1949.	
1949.		Sept. 29 ,, Valuation ..	460 0 0
Sept. 29 ,, Profit & Loss A/c.	210 0 0		
	£1,390 0 0		£1,390 0 0

PIGS ACCOUNT

Dr.	£ s. d.		Cr. £ s. d.
1948.		1949.	
Sept. 29 To Valuation ..	15 0 0	Sept. 29 By Valuation	20 0 0
1949.			
Sept. 29 ,, Profit & Loss A/c.	5 0 0		
	£20 0 0		£20 0 0

F. DUNN

Dr.	£ s. d.		Cr. £ s. d.
1948.		1949.	
Sept. 29 To Balance	20 0 0	Sept. 29 By Balance	20 0 0

S. FARR

Dr.	£ s. d.		Cr. £ s. d.
1948.		1949	
Sept. 29 To Balance	30 0 0	Sept. 29 By Balance	30 0 0

J. CROWE

Dr.	£ s. d.		Cr. £ s. d.
1948.		1949.	
Sept. 29 To Balance	50 0 0	Sept. 29 By Balance	50 0 0

G. HOWES

Dr.	£ s. d.		Cr. £ s. d.
1948.		1949.	
Oct. 13 To Corn, Hay & Straw A/c.	360 0 0	Mar. 3 By Cash A/c. ..	360 0 0

FEEDING STUFFS ACCOUNT

Dr.	£ s. d.		Cr. £ s. d.
1948.		1949.	
Dec. 24 To R. Walls' A/c.	90 0 0	Sept. 29 By Profit & Loss A/c.	90 0 0

R. WALLS' ACCOUNT

Dr.	£ s. d.		Cr. £ s. d.
1949.		1948.	
Sept. 13 To Bank A/c.	85 10 0	Dec. 24 By Feeding Stuffs A/c.	90 0 0
Sept. 13 ,, Discount A/c.	4 10 0		
	£90 0 0		£90 0 0

SEEDS ACCOUNT

Dr.	£ s. d.		Cr. £ s. d.
1949.		1949.	
Mar. 29 To A. Clucas' A/c.	28 0 0	Sept. 29 By Profit & Loss A/c.	28 0 0

A. CLUCAS

Dr.	£ s. d.		Cr. £ s. d.
1949.		1949.	
Aug. 2 To Bank A/c.	26 12 0	Mar. 29 By Seeds A/c.	28 0 0
Aug. 2 ,, Discount A/c.	1 8 0		
	£28 0 0		£28 0 0

RENT ACCOUNT

Dr.	£ s. d.		Cr. £ s. d.
1949.		1949.	
April 4 To Bank A/c.	130 0 0	Sept. 29 By Profit & Loss A/c.	260 0 0
Sept. 29 ,, Landlord ..	130 0 0		
	£260 0 0		£260 0 0

DISCOUNT ACCOUNT

Dr. 1949.		£ s. d.	1949.		Cr. £ s. d.
Sept. 29	To Profit & Loss A/c. ..	5 18 0	Aug. 2	By J. Clucas	1 8 0
			Sept. 13	,, R. Walls' A/c.	4 10 0
		£5 18 0			£5 18 0

MILK AND EGGS ACCOUNT

Dr. 1949.		£ s. d.	1949.		Cr. £ s. d.
Sept. 29	To Profit & Loss A/c. ..	70 0 0	July 27	By Cash A/c.	70 0 0

M. TAPLEY

Dr. 1949.		£ s. d.	1949.		Cr. £ s. d.
Sept. 24	To Corn, Hay and Straw A/c.	330 0 0	Sept. 29	By Balance	330 0 0

LANDLORD

Dr. 1949.		£ s. d.	1949.		Cr. £ s. d.
Sept. 29	To Balance	130 0 0	Sept. 29	By Rent A/c.	130 0 0

A. BLACK (LOAN)

Dr. 1949.		£ s. d.	1949.		Cr. £ s. d.
Mar. 25	To Bank A/c.	100 0 0	Sept. 29	By Bank A/c...	50 15 0
Sept. 25	,, Interest A/c.	1 10 0	Sept. 29	,, Bad Debts A/c.	50 15 0
		£101 10 0			£101 10 0

GENERAL EXPENSES ACCOUNT

Dr. 1949.		£ s. d.	1949.		Cr. £ s. d.
Aug. 2	To Cash A/c.	10 0 0	Sept. 29	By Profit & Loss A/c. ..	10 0 0

INTEREST ACCOUNT

Dr. 1949.		£ s. d.	1949.		Cr. £ s. d.
Sept. 29	To Profit & Loss A/c. ..	1 10 0	Sept. 25	By A. Black's A/c.	1 10 0

B. DEALER

Dr. 1949.		£ s. d.	1949.		Cr. £ s. d.
Sept. 26	To Cattle A/c.	370 0 0	Sept. 29	By Balance	370 0 0

INSURANCE ACCOUNT

Dr. 1949.		£ s. d.	1949.		Cr. £ s. d.
Sept. 28	To Bank A/c.	20 0 0	Sept. 29	By Profit & Loss A/c. ..	20 0 0

WAGES ACCOUNT

Dr. 1949.		£ s. d.	1949.		Cr. £ s. d.
—	To Bank A/c.	750 0 0	Sept. 29	Bv Profit & Loss A/c. ..	750 0 0

BAD DEBTS ACCOUNT

Dr. 1949.		£ s. d.	1949.		Cr. £ s. d.
Sept. 29	To A. Black's A/c.	50 15 0	Sept. 29	By Profit & Loss A/c. ..	50 15 0

PROFIT AND LOSS ACCOUNT

Dr. 1949.		£ s. d.	1949.		Cr. £ s. d.
—	To Depreciation	72 0 0	—	By Corn, Hay and Straw ..	1,330 0 0
	,, Feeding Stuffs	90 0 0		,, Growing Crops	80 0 0
	,, Seeds	28 0 0		,, Cattle	210 0 0
	,, Rent	260 0 0		,, Pigs	5 0 0
	,, General Expenses ..	10 0 0		,, Discount	5 18 0
	,, Insurance	20 0 0		,, Milk	70 0 0
	,, Wages	750 0 0		,, Interest	1 10 0
	,, Bad Debts..	50 15 0			
	,, Capital A/c. being Net Profit	421 13 0			
		£1,702 8 0			£1,702 8 0

BALANCE SHEET OF A. CHESHER, KEIR FARM, 29th SEPTEMBER, 1949

Dr. LIABILITIES. 1949.		£ s. d.	ASSETS. 1949.		£ s. d.
—	To Sundry Creditors:		—	By Cash in Hand	10 0 0
	Landlord	130 0 0		,, Cash in Bank	378 13 0
	J. Crowe	50 0 0		,, Valuations:	
	Capital	3,326 13 0		Corn, Hay and Straw	860 0 0
				Implements	408 0 0
				Growing Crops	340 0 0
				Horses	280 0 0
				Cattle	460 0 0
				Pigs	20 0 0
				,, Sundry Debtors:	
				F. Dunn	20 0 0
				S. Farr	30 0 0
				B. Dealer	370 0 0
				M. Tapley	330 0 0
		£3,506 13 0			£3,506 13 0

Private Life.

The Farmer's life is so much involved in the 'arm, and the farm on many occasions so much nixed up with his domestic activities that, unless :are is taken to analyze and separate what is irectly associated with the management of the ırm from what might be termed his social and omestic affairs, the true results of the farm ıanagement cannot possibly be ascertained.

Supporting and educating the family, together ith other claims on the exchequer such as oliday and private expenses must not be conısed with the permissible farm expenditure. There is also the consumption of the farm roduce in the household, which on some holdings , very large, together with the practice in certain istricts of boarding farm workers.

The labour done by the farmer's family is nother matter which creates problems of ccountancy which unless they are dealt with roperly are liable to be detrimental to the farmer, nd to his family.

There is nothing to prevent the farmer from using one quarter of his capital or even the whole of it just as he pleases, but it is wise in these times to make a record of it both in his own interests and in the interests of the family. Taking the opposite view there is no reason why the farmer should not increase his capital from private sources, but he is expected to do so in accordance with the rules of sound business.

The points in question increase or decrease the farmer's Capital and can be treated directly through the Capital Account, but perhaps it is better to keep this Account concise, and free from extras, so that the Capital and that which affects it each year can be seen at a glance.

Since the business under consideration is of a private nature, the opening of a Private Account is the most simple line of approach, but frequently a Drawings Account is opened which can be regarded as the same thing.

If the farmer takes a trip to America and he draws £200 from the Bank to defray some of the expenses he will credit his Bank Account and debit the Private Account.

PRIVATE ACCOUNT

Dr.		Cr.	
To Bank A/c.	£200		

BANK ACCOUNT

Dr.		Cr.	
		By Private A/c.	£200

The Private Account will be closed into the Capital Account. This will increase or reduce the Capital which is exactly what has happened.

CAPITAL ACCOUNT

To Private A/c.	£200	By Balance	£7,000
,, Balance	6,800		
	£7,000		£7,000

PRIVATE ACCOUNT

To Bank A/c.	£200	By Capital A/c.	£200

It will be noticed that the farm is not charged with this expense as it is not necessary to go to America in order to manage a farm in England. The farmer might put forward the plea that the trip was made to broaden his farming outlook and that the farm will derive the benefit from this

journey. Apart from members of the family there are others whom it would be difficult to convince that the £200 would be a charge against the farm.

If the farmer were a Shire breeder and his horse business connections invited him to a race meeting where he won £400, he would debit his Bank Account and Credit the Private Account.

BANK ACCOUNT

To Private A/c.	£400		

PRIVATE ACCOUNT

To Capital A/c.	£400	By Bank A/c.	£400

The Private Account Balance would be taken to the Capital Account, which would increase his Capital by £400. The farm does not show this as a profit as the outing had nothing to do with the farm management.

CAPITAL ACCOUNT

To Balance	£7,200	By Balance	£6,800
		,, Private A/c.	400
	£7,200		£7,200

Farm Produce Consumed in the Farm House.

If the proprietor of a general store supplied his house with everything in which he traded, it might be possible to discover that the supplies amounted to £500 per annum or more. If the said proprietor did not make a record of these happenings, the business records would be incorrect to the extent of £500.

The writer wrote Accounts for a Home Farm, which was run in conjunction with two mansions, one with 100 rooms and the other considerably smaller. If the landowner had looked upon himself as a farmer producing food for his household, the farm would always have shown a loss.

By treating the management of the farm as though it were run by a tenant, it was seen that the farm made a profit. Although the principle of separating the one from the other is more obvious in larger concerns than in smaller units, it will gradually become more necessary as modern changes occur to comply with these principles in all cases.

One method of recording the farm produce consumed by the occupants of the farm house is to credit the Produce Account as a sale in the ordinary way and to debit the Private Account.

FARM PRODUCE ACCOUNT

Dr.			Cr.
		By Private A/c.	£50

PRIVATE ACCOUNT

To Farm Produce A/c.	£50		

Working Members of the Farmer's Family.

Take an example of two farmers each farming three hundred acres with the same annual rental.

The first farmer works the holding with two ploughmen whose wages total £300. The second farmer works his holding with two sons and does not charge the value of the sons' labour against the farm and consequently shows a different result. To rectify the difference between the two cases it would be necessary to charge the farm with the value of the labour done by the family and to credit the Private Account. The simpler and safer method and the one that protects all parties is to pay wages at the usual regular intervals and so avoid possible awkward incidents in the future.

Board of Working Members of the Family.

The value of the board of working members of the family can be charged against the farm just in the same way as the value of the board of farm workers living in the house. In the event of omitting to make these charges against the profit of the farm, the farmer will show a profit higher than which is actually the true profit. The values to be charged are generally governed by the rates common to the district unless satisfactory evidence can be given for requesting that higher figures should be used.

PRIVATE ACCOUNT

		By Wages A/c. (Value of Board)	£100

WAGES ACCOUNT

To Private A/c.	£100		

Private Bank Account.

Just as certain other business men have No. 1, No. 2, and No. 3 Bank Accounts for three separate farms or businesses the one-farm farmer can have a Private Bank Account for his private affairs and a Business Bank Account for the financial transactions of the farm.

However, in ordinary cases one Bank Account

will be sufficient provided a record of all private transactions is made.

It would be sufficient to credit the Bank with £120 and to debit the Private Account with the same amount. If this sum appeared frequently it would be to the farmer's interest to be able to investigate the entries and that could be done by keeping a private diary or other book of similar type.

Partnership Accounts.

Partnership is defined by the Partnership Act, 1890, as being "the relation which subsists between persons carrying on a business in common with a view to profit."

The number of persons, termed "partners," who may form a partnership is limited to ten in a banking business, and to twenty in any other undertaking. If more, the undertaking must be registered under the Companies Act.

Kinds of Partners.

There are different kinds of partners, viz:—

Ordinary (or Active) Partner, i.e., one who has capital in the firm and takes an active part in the conduct of the business.

Sleeping (or Dormant) Partner, i.e., one who has capital in the firm, but takes no actual part in the conduct of the business. Such a partner is responsible for the debts of the firm as if he were an ordinary partner. His name may or may not appear in the firm's name.

Nominal (or Apparent or Ostensible or Quasi) Partner, i.e., a person who, whilst not a partner, in some way lends his name to a business. Such a person is said to be "holding out" as a partner, and is therefore liable as a partner for credit given to the firm on the assumption that he was actually a member of the firm.

The term Quasi Partner is also sometimes applied to a person who has been a partner but who has retired from the firm, leaving capital in the business in the form of a loan on which interest, varying with the profits, is paid. Such a person is strictly not a partner, but a deferred creditor, as the loan is not repayable until after all outside creditors of the firm have been paid.

Deed of Partnership.

When a partnership is formed it is usual to draw up a legal document, termed the Deed of Partnership, although a partnership may be carried on by verbal agreement.

The Deed of Partnership defines the rights and interests of the members and is signed by all partners of the firm.

A partnership Deed should contain clauses relating to:—

(1) The firm name, the nature of the business to be carried on, and the address or addresses at which business is to be transacted.
(2) The commencement and duration of the partnership.
(3) The amount of capital to be contributed by each partner, and interest thereon (if any).
(4) The division of profits or losses.
(5) Partners' salaries or remuneration (if any).
(6) Loans by partners to the firm and interest thereon.
(7) Drawings and interest thereon.
(8) The keeping of proper books and periodical audit.
(9) The adjustment and repayment of capital, including goodwill (if any) of a deceased or retired partner.
(10) Arbitration in order that any partnership disputes may be settled without recourse to litigation.

In the absence of any agreement between the partners the Partnership Act, 1890, provides that:—

(1) Partners are entitled to share equally in the capital and profits of the business, and must contribute equally to losses, whether of capital or otherwise, sustained by the firm.
(2) No interest is payable in respect of capital before the ascertainment of profits, but parties are entitled to interest at 5 per cent per annum on advances apart from capital.
(3) Every partner may take part in the management of the business, but no partner is entitled to salary for his services.
(4) No person may be introduced as a partner without the consent of all existing partners.
(5) The partnership books are to be kept at the place of business, and every partner may have access to them.

Liabilities and Rights of Partners.

The receipt by a person of a share of the profits of a business is ordinarily considered evidence that he is a partner.

Liability For Partnership Debts.

In an ordinary partnership the liability of the partners for the partnership debts is unlimited. i.e., if the partners' capital in the business is insufficient to meet the business obligations, their private property is subject to be called upon to meet the liabilities.

Every partner in a firm is liable jointly with the other partners, and in Scotland severally also, for all debts of the firm incurred while he is a partner, and after his death his estate is also severally liable for such debts so far as they remain unsatisfied, but subject in England (but

not in Scotland), to prior payment of his separate debts.

Liability to Account.
Unless expressly agreed to the contrary, every partner must account to the firm for any individual profit derived by him from transactions arising out of or in competition with the partnership.

Incoming Partner.
When a person joins an existing firm as a partner, he does not thereby become liable for debts contracted prior to his admission.

Outgoing Partner.
When a partner retires, he remains liable for the debts of the firm incurred previous to retirement, but he may be released from existing liabilities by an agreement between himself, the new firm, and the creditors. The creditors, however, must assent to the release, otherwise his liability to them remains.

A retiring partner may be held liable for debts incurred after the dissolution unless all persons who have had dealings with the firm are duly notified of the change.

The retiring partner must also, to escape possible liability for debts contracted after his retiral, advertise notice of the dissolution, so that the public may be made aware of the change in the firm.

Limited Partnerships.
The Limited Partnerships Act, 1907, permits a special kind of partnership, whereby one or more of the partners, styled "limited" partners, may introduce capital into a business without incurring liability beyond the amount which they contribute. By taking advantage of this Act, fresh capital can be brought into a concern without incurring the expense attending the formation of a company registered under the Companies Act.

Constitution of a Limited Partnership.
A limited partnership must consist of one or more persons, styled "general" partners, who shall be liable for all debts and obligations of the firm, and one or more persons, styled "limited" partners, who shall, at the time of entering the partnership, contribute thereto a sum or sums as capital or property valued at a stated amount, and who shall not be liable for the debts and obligations of the firm beyond the amount so contributed. A body corporate may be a limited partner.

Interest on Capital.
It is the custom to allow interest on the amount of capital contributed by each partner, particularly in cases where the shares of the partners are unequal. Such provision is usually provided for in the partnership agreement. In the absence of any agreement, then, in accordance with the Partnership Act, interest is not allowed on Capital.

Suppose A and B engaged in partnership, A contributing £3,000 and B £6,000 it is evident that if no interest is allowed on capital, A, with £3,000 less employed, would be reaping some advantage at the expense of B, who is entitled to some recompense in the shape of interest for the additional capital invested by him.

Interest credited to partners upon their capital is debited to Interest Account, and forms a charge against the farm prior to division of the net profits.

The Accounts of a simple Partnership can be shown by taking the accounts of A. Chesher, Keir Farm, Newport, which have already been completed. Assume as an illustration that A. Chesher was in Partnership with B. Brown. The change in procedure would be seen in the Balance Sheets, the Capital Accounts, the Private Accounts and in the Profit and Loss Account.

BALANCE SHEET OF A. CHESHER AND B. BROWN,

KEIR FARM, NEWPORT, 29th SEPTEMBER, 1948

LIABILITIES.	£	s.	d.	ASSETS.	£	s.	d.
Sundry Creditors				Cash in Hand	40	0	0
J. Crowe	50	0	0	Cash in Bank	960	0	0
A. Chesher's Capital	1,477	10	0	Valuations:			
B. Brown's Capital	1,477	10	0	Corn, Hay and Straw	600	0	0
				Implements	480	0	0
				Growing Crops	260	0	0
				Horses	200	0	0
				Cattle	400	0	0
				Pigs	15	0	0
				Sundry Debtors:			
				F. Dunn	20	0	0
				S. Farr	30	0	0
	£3,005	0	0		£3,005	0	0

A. CHESHER'S CAPITAL ACCOUNT

	£ s. d.		£ s. d.
To Private A/c.	50 0 0	By Balance	1,477 10 0
,, Balance	1,638 6 6	,, Profit & Loss A/c.	210 16 6
	£1,688 6 6		£1,688 6 6

A. CHESHER'S PRIVATE ACCOUNT

	£ s. d.		£ s. d.
To Cash	50 0 0	By Capital Account	50 0 0

B. BROWN'S CAPITAL ACCOUNT

	£ s. d.		£ s. d.
To Balance	1,688 6 6	By Balance	1,477 10 0
		,, Profit & Loss Account	210 16 6
	£1,688 6 6		£1,688 6 6

B. BROWN'S PRIVATE ACCOUNT

PROFIT AND LOSS ACCOUNT

	£ s. d.		£ s. d.
To Depreciation	72 0 0	By Corn, Hay and Straw	1,330 0 0
,, Feeding Stuffs	90 0 0	,, Growing Crops	80 0 0
,, Seeds	28 0 0	,, Cattle	210 0 0
,, Rent	260 0 0	,, Pigs	5 0 0
,, General Expenses	10 0 0	,, Discount	5 18 0
,, Insurance	20 0 0	,, Milk	70 0 0
,, Wages	750 0 0	,, Interest	1 10 0
,, Bad Debts	50 15 0		
,, A. Chesher's Capital Account ..	210 16 6		
,, B. Brown's Capital Account ..	210 16 6		
	£1,702 8 0		£1,702 8 0

It will be seen that each partner at the beginning of the year has the same amount of Capital invested in the farm. A. Chesher has drawn £50 out of the farm business for private purposes. The Profits are shared equally and transferred to the respective Capital Accounts.

The Final Balance Sheet shows that A. Chesher's Capital amounts to £1,638 6s. 6d., while B. Brown's Capital is £1,688 6s. 6d.

BALANCE SHEET OF A. CHESHER AND B. BROWN,

KEIR FARM, NEWPORT, 29th SEPTEMBER, 1949

LIABILITIES.		£ s. d.	ASSETS.	£ s. d.
Sundry Creditors:			Cash in Hand	10 0 0
Landlord		130 0 0	Cash in Bank	378 13 0
J. Crowe		50 0 0	Valuations:	
A. Cheshire's Capital	£1,638 6 6		Corn, Hay and Straw	860 0 0
B. Brown's Capital	£1,688 6 6	3,326 13 0	Implements	408 0 0
			Growing Crops	340 0 0
			Horses	280 0 0
			Cattle	460 0 0
			Pigs	20 0 0
			Sundry Debtors:	
			F. Dunn	20 0 0
			S. Farr	30 0 0
			B. Dealer	370 0 0
			M. Tapley	330 0 0
		£3,506 13 0		£3,506 13 0

Trading Account.

The Trading Account is drawn up in conjunction with the Profit and Loss Account.

The Trading Account shows the GROSS Profit on the Sales after charging the purchases and other items of direct cost.

The Profit and Loss Account shows the NET Profit or loss made for the period.

The trading Account should include on the Debit Side:—

Opening Stock on hand.
Purchases less returns.
Wages (Productive).
Carriage on purchases.

On the Credit Side:—

Sales less returns.
Closing Stock, i.e., the value of the stock unsold at the end of the period.

The difference between the two sides of the Trading Account represents the Gross Profit made, and is transferred to the Credit of the Profit and Loss Account. A Trading Account may sometimes show a Gross Loss, in which case the entry would be a debit to the Profit and Loss Account.

The Profit and Loss Account contains, on the Credit side the Gross Profit shown by the Trading Account (and any other profits which may have been earned) and on the Debit Side all the expenses or losses incurred in managing the farm such as Rent, Salaries, Depreciation, General Expenses, Discount, Bad Debts, and Interest.

The difference between the two sides of the Profit and Loss Account is the final result of the farmer's operations for the period, and is either net profit, when the gains exceed the losses, or net loss, when the losses exceed the gains.

TRADING ACCOUNT

To Opening Stock	£2,000	By Sales *less* Returns	£3,000
,, Purchases *less* Returns	1,800	,, Closing Stock	2,300
,, Wages	600		
,, Carriage on Purchases	50		
,, Profit & Loss A/c., being Gross Profit	850		
	£5,300		£5,300

PROFIT AND LOSS ACCOUNT

To Rent	£350	By Trading A/c. Gross Profit	£850
,, Salary	150		
,, General Expenses	40		
,, Discount	10		
,, Interest	5		
,, Bad Debts	16		
,, Capital A/c. being Net Profit	279		
	£850		£850

Sometimes Departmental Trading Accounts are presented to show the Gross Profits or Loss from the different departments before transferring the Balances to the Profit and Loss Accounts.

TRADING ACCOUNT

April, 1949			April, 1950	
Horses	Valuation	£450	Valuation	£420
	Purchases	150	Sales	300
	Wages	40		
To Profit & Loss Gross Profit		80		
Cattle	Valuation	2,500	Sales	700
	Purchases	300	Valuation	2,400
	Wages	250		
Gross Profit		100		
Hay	Valuation	90	Sales	500
	Purchases	—	Valuation	80
	Wages	50		
Gross Profit		440		

Owner and Owner-Occupier's Account.

If A. Chesher had owned Keir Farm, Newport, Shropshire, and had let it to a tenant at a rent of £260, he would have prepared an account so that he could have ascertained whether he had made a profit or a loss as a landowner, and that Account would have been termed an Owner Account or an Estate Account.

OWNER ACCOUNT (or ESTATE ACCOUNT)

To Valuation	£5,200	By Bank (Rent)	£260
,, Bank for (Repairs)	60	,, Valuation	5,200
,, Bank (Land Tax)	5		
,, Bank (Rates)	22		
,, Bank (Tithe)	30		
,, Balance being Profit	143		
	£5,460		£5,460

From this Estate Account it is seen that £5,200 has been invested in Land and Buildings, and that there have been the usual landowner's expenses, such as Rates, Land Tax, Tithe, and Repairs, etc., charged against the Business. On the credit side is seen the Income of the business, and when that is placed against the expenses of the business it is seen that a Balance of £143 is left, which can be looked upon as the annual return from the estate or business.

If the view is now taken that A. Chesher owned Keir Farm, Newport, Shropshire, and also farmed it, he would be known as the Owner-Occupier. He would prepare Accounts each year to show the return from landownership, and he would prepare separate accounts to show his financial results as a tenant for the year.

ESTATE ACCOUNT

To Valuation	£5,200	By Rent A/c.	£602
,, Bank (Repairs)	60	Valuation	5,200
,, Bank (Land Tax)	5		
,, Bank (Rates)	22		
,, Bank (Tithe)	30		
,, Balance being Profit	143		
	£5,460		£5,460

The only difference between this Estate Account and the previous one is observed in the Rent on the credit side. There is no point in a person paying a rent to himself but the rent has to be shown to complete the account for the year.

The result of the second business, which is that of a Tenant Farmer can best be seen in this case by turning back to the completed accounts of A. Chesher's Farm Accounts.

The Balance Sheet will show the amount of Tenant's Capital invested in the farm which is £2,955. All the other Accounts will be written up exactly the same with the exception of the Rent Account.

RENT ACCOUNT

To Estate A/c.	£260	By Profit & Loss A/c.	£260

The Rent Account shows that it has been debited to the Estate Account and not to the Bank Account, as no money has passed.

The Profit and Loss Account is closed with a credit balance of £421, which is the return for the year as a Tenant.

Cash Book.

The Cash Account and the Bank Account are Ledger Accounts but the entries are so numerous that in practice it is thought advisable to keep them in a separate book known as the Cash Book.

It might be said that there should be two Books, one for the Cash transactions and the other for the transactions that pass through the Bank. In view of the fact that farmers are advised to make most of their transactions through the Bank, the one book dealing with the two accounts meets with all their requirements.

CASH BOOK

Dr Receipts.

Date	Particulars	Detail	Folio	Cash	Bank
				£ s. d.	£ s. d.
	To Balance	—	—	15 0 0	1,500 0 0

Cash in Hand, £15. Cash in Bank, £1,500.

PAYMENTS. Cr.

Date	Particulars	Detail	Folio	Cash	Bank
				£ s. d.	£ s. d.
	By Cattle A/c.	4 milk cows	—	—	160 0 0

Paid by cheque, £160 for milk cows.

The receipt side of this Book has a Cash Column and a Bank Column. The payment side is also provided with these money columns. If the farmer draws money from the Bank for the Cash Box, debit the Cash Column because the Cash Box receives, and credit the Bank Column.

When the surplus of cash in the Cash Box is banked, debit the Bank Column because the Bank receives and credit the Cash Column.

In this Cash Book all cash received in coin or notes is entered in the cash column—Dr. side.

All payments made in cash are entered in the cash column—Cr. side.

All cheques received and lodged in the bank are entered on the Dr. side of the bank column, because the money will be received through the Bank. All payments made by cheque will be entered on the Cr. side, bank column, because the money will be paid through the bank.

When there is more ready money in the cash-box than is required for cash payments, then pay the surplus into the bank; or, again, should ready money run short, draw cash from the bank by means of a cheque payable to self.

When paying cash to the bank out of the cash-box, the entry is made on the Cr. side, " By Paid to Bank " (or " Cash Banked "), and the amount is extended to the Cash column—being paid out of cash. To complete the double entry, enter on the Dr. side the amount received by the bank, viz., " To Cash Paid to Bank " (or " Cash Banked "), and extend it to Bank column.

On the other hand, when the farmer draws cash from the bank for office use, directly opposite entries are made, viz., Cash column is debited " To Cash from Bank " because cash is received, and Bank column is credited " By Cash from Bank," because cash is drawn from the bank.

By using such a Columnar Cash Book it is possible to ascertain at any time the amount of cash in hand or at the bank.

If the farmer lodges in the bank, on the same day, cheques and other payments, received from different customers, it is convenient to add another column to the Cash Book, so as to group the items so banked. The details of the cheques, and cash (if intended to be banked) are entered in the Details column, and the total extended to the Bank column. The sum lodged in the bank will, therefore, agree with the entry in the Bank Pass Book.

Purchases Day Book.

Day Books cannot be generally recommended for the use of the farmer. They may, however, be used in large farming or trading concerns or on estates.

The Purchases Day Book, sometimes termed The Purchases Journal, or Bought Book, is used to record goods bought on credit (i.e., not paid for at the time).

All goods received should be examined on receipt, and weighed or counted, and compared with the Order Book, and the Invoice checked to confirm that the details are correct before the items, names and amounts are entered into the Purchases Book.

The Ruling of the Purchases Book is arranged in accordance with the nature of the business. Analyses columns are used when dealing with various classes of purchases such as cattle, sheep, and feeding stuffs, and not with solitary annual purchases.

PURCHASES DAY BOOK

Date	Details	Ledger Folio	Cattle	Sheep	Feeding Stuffs
1950 April 3	J. Logan 20 Heifers at £20 each		£400		
April 9	R. McNaughton 300 Sheep at £2 each			£600	
April 13	J. Gartshore 4 tons Feeding Stuffs				£48
			£400	£600	£48

The transactions are now to be recorded in the Ledger. The giving accounts are Logan, McNaughton, and Gartshore, and the receiving accounts are Cattle, Sheep and Feeding Stuffs. The details are posted to the Ledger by crediting the Accounts of Logan, McNaughton and Gartshore with £400, £600 and £48 respectively and debiting the Cattle Account, Sheep Account, and Feeding Stuffs Account.

Each item concerning a Personal Account must be posted separately. The total to be debited to the Cattle Account or either of the other two accounts is obtained monthly from the Purchases Day Book. Therefore, by posting in one amount the total purchases of cattle for one month, the double entry is completed, and the same applies to the Sheep and Feeding Stuffs.

Sales Day Book.

The Sales Day Book is used to record the Sales on credit as they take place. When orders are received it is customary to enter the particulars in the Orders Received Book.

When the goods are despatched the entry in the Sales Day Book is made from a Goods Despatched Book or copy of Invoice sent to the customer.

The Sales Day Book can be ruled with Analyses Columns if desired.

SALES DAY BOOK

Date	Details	Ledger Folio	Cattle	Sheep	Swedes
April 21	J. Evans 10 Cattle at £21 each		£210		
April 21	R. Green 200 sheep at 41/–			£410	
April 29	Jar & Co. 20 tons Swedes at £3 per ton				£60
			£210	£410	£60

The individual items are posted to the debit of the Personal Accounts and the monthly totals to the credit of the Cattle, Sheep, and Swedes Account.

Petty Cash Book.

On Estates, and in large farming concerns as in other businesses, it is the practice, in order not to burden the Cash Book with small payments, to record small expenses such as telegrams, postages, stationery, market expenses, etc., in the Petty Cash Book, on what is termed the Imprest System.

The Petty Cash Book, for example, might be debited at the beginning of the month with £10, which is the amount estimated to meet the expenses for the month. The payments are extended to the Analyses columns and if the total expenditure amounts to £10 for the month, the amount required to start the new period will be drawn from the Bank and debited to the Petty Cash Book. Whoever is responsible for the Petty Cash must account for his disbursements. The totals of the analyses columns are posted to the debit of the respective accounts in the Ledger at the end of the month.

PETTY CASH BOOK

Dr. | Cr.

Date	Amount Received	Folio	Date	Details of Payments	Total	Telegrams	Postages	Other Expenses
	£ s. d.				£ s. d.		£ s. d.	£ s. d.
April 1	10 0 0		April 1	Market Expenses	3 0 0			3 0 0
,, 30	10 0 0		,, 3	Stamps	5 0 0		5 0 0	
			,, 20	Telegrams	0 4 0	4/–		
			,, 29	Other Expenses	1 16 0			1 16 0
					10 0 0	4/–	5 0 0	4 16 0
			,, 30	Balance in Hand	10 0 0			
	£20 0 0				£20 0 0			
May 1 To Bal. brought forward	£10 0 0							

Farm Diary.

The Farm Diary is a most useful book even if it be only of the pocket type. There is an advantage in having a larger size to be kept in the house, as it gives more space for writing. The Diary, apart from containing particulars relating to the accounting of the farm, can be used for anything which will be of interest in the future.

The Diary is kept from day to day, and entries such as " Ploughing A (two pairs) " or " Discing with the tractor in field B " are examples of the happenings that are recorded. So also are the following:—

> " Drilling Oats in field S. Flossie calved heifer calf. Good or bad weather. Opened roads in fields X and Y; 2 men.
> Lifting and pitting potatoes, field M. 2 acres. Rain stopped work 4 p.m."

The value of the Diary to the farmer will be increased if he records the particulars of the work done very fully.

Every day throughout the year there should be a record of some kind. This will enable the farmer to see at a glance the amount and type of work that has been done during the spring, summer, autumn and winter.

When using the Diary for accounting purposes it is better to have a book with a money column. Many farmers enter all the cash transactions as well as the credit transactions in the Diary.

After a credit transaction has been settled it is struck off the book. This simplifies the making of the list of Sundry Debtors and Sundry Creditors at the end of the year. Here are examples:—

> " Bought 4 tons Palm Kernel from Walls at £9 per ton on Rail (credit).
>
> Sold cows to D. Smith, £50 (cash).
>
> Bought 100 lambs, Auction, at 33/– (cash).
>
> Sold 4 calving heifers to B. Brown, £180 (credit).
>
> Bought Gelding, Perth, £200 (cash).
>
> Sold Oats to Walls, 2 ton 5 cwt., at £10 (credit).
>
> Sold Potatoes to Campbell, 20 tons at £6 (credit)."

Journal.

The Journal at one time was used for recording every transaction. In modern practice it is used for recording transactions which cannot be passed through the Day books, such as Depreciation, Bad Debts, Interest, Transfer Entries and Opening and Closing Entries.

Journalizing is based on the principle of Double Entry. Every debit must have a credit entry.

The Account that is debtor is given first, followed by the word " Debtor " (Dr.).

The Account which is creditor follows on the next line, and the particulars of the transaction are briefly noted.

An example of how transactions are journalized can be seen by taking some of the transactions in the Exercise, *A. Chesher, Keir Farm.*

On 13th October, 1948, he sold oats to H. Howes. Howes' Account receives and is debited, and as the Oats Account gives, it is credited. In Journal language it is written " Howes' A/c. Dr. to Oats A/c.", and the particulars are briefly noted.

In opening the Books of A. Chesher it is necessary to open Ledger Accounts from the Balance Sheet and the opening entries are taken from the Assets and Liabilities.

The Bad Debts incurred in Black's Account is Journalized:—" Bad Debts Dr. to Black."

The Closing entries are the balances taken to the Profit and Loss and Capital Accounts.

The Journal is often regarded as a useful book for theory purposes because it may enable the beginner to understand the meaning of Double Entry. Beginners may, therefore, find it useful to practise and acquire facility in journalizing.

Since there is so much repetition work entailed in Journalizing, and subsequent posting, and since the Accounting is not speeded up in any way, the farmer may be well advised to pass the transactions through the Ledger and save time by obtaining the same final correct result.

JOURNAL

		Dr. £	s.	d.	Cr. £	s.	d.
1948 Oct. 13	G. Howes						
	To Oats	360	0	0	360	0	0
	Seed Oats sold to him						
Dec. 24	Feeding Stuffs	90	0	0			
	To R. Walls				90	0	0
	Feeding Stuffs bought from him						
1949 Feb. 28	Cash	380	0	0			
	To Wheat				380	0	0
	Wheat sold to M. Tapley						

JOURNAL

Date	Particulars	Dr. £	s.	d.	Cr. £	s.	d.
	OPENING ENTRIES						
	Cash	40	0	0			
	Bank	960	0	0			
	Corn, Hay and Straw	600	0	0			
	Implements	480	0	0			
	Growing Crops	260	0	0			
	Horses	200	0	0			
	Cattle	400	0	0			
	Pigs	15	0	0			
	F. Dunn	20	0	0			
	S. Farr	30	0	0			
	To J. Crowe				50	0	0
	Capital				2,955	0	0
		£3,005	0	0	£3,005	0	0
	Bad Debts	50	15	0			
	To Black				50	15	0
	Bad Debts written off						
	CLOSING ENTRIES						
1949 Sept. 29	Corn, Hay and Straw Account	1,330	0	0			
	To Profit and Loss Account				1,330	0	0
,, 29	Growing Crops, Account	80	0	0			
	To Profit and Loss Account				80	0	0
,, 29	Cattle Account	210	0	0			
	To Profit and Loss Account				210	0	0
,, 29	Pigs Account	5	0	0			
	To Profit and Loss Account				5	0	0
,, 29	Profit and Loss Account	90	0	0			
	To Feeding Stuffs Account				90	0	0
,, 29	Profit and Loss Account	28	0	0			
	To Seeds Account				28	0	0
,, 29	Profit and Loss Account	260	0	0			
	To Rent Account				260	0	0
,, 29	Discount Account	5	18	0			
	To Profit and Loss Account				5	18	0
,, 29	Milk and Eggs Account	70	0	0			
	To Profit and Loss Account				70	0	0
,, 29	Profit and Loss Account	10	0	0			
	To General Expenses Account				10	0	0
,, 29	Interest Account	1	10	0			
	To Profit and Loss Account				1	10	0
,, 29	Profit and Loss Account	20	0	0			
	To Insurance Account				20	0	0
,, 29	Profit and Loss Account	750	0	0			
	To Wages Account				750	0	0
,, 29	Profit and Loss Account	50	15	0			
	To Bad Debts Account				50	15	0
,, 29	Profit and Loss Account	421	13	0			
	To Capital Account				421	13	0

Terms used in Business.

Account Current—A running account with a banker, which may be added to or drawn upon at any time. An account in a merchant's book on which interest is usually debited and credited. The copy of the account which is sent at regular periods to the customer.

Account Rendered—A statement showing the amount due, full details of which have been previously sent. Thus:—

April 30, 1950 (the date the detailed account was sent)—To account rendered, £50.

Agent—One authorized to transact business for another. Any contracts entered into by an agent, on behalf of his principal, are binding upon his employer if made in the ordinary course of business.

Agreement—A bargain or contract entered into between two or more parties. Agreement may be (1) verbal, (2) in writing " under hand," or (3) in writing " under seal."

Arbitration—The settlement of disputes by a neutral party.

Assessment—The valuation or amount for taxation purposes.

Assets—A person's or company's property.

Assets, Liquid—Assets readily convertible into cash, such as marketable securities, bills of exchange, or book debts.

Award—The decision given by an arbiter.

Bad Debts—When an account is irrecoverable it should immediately be written off to a " Bad Debts " Account.

Balance—The difference between two sides of an account.

Balance Sheet—A statement of the balance of the accounts in the Ledger arranged under assets and liabilities.

Bankrupt—One who has been judicially declared insolvent.

Consignment—Goods which are sent to be sold on one's behalf.

Cost, Insurance and Freight, C.I.F. or C.F.I.—The price including the cost of the freight and insurance as well as the goods. C. and F. is the price (cost) and freight without insurance.

Credit Note—A statement sent to a customer giving particulars of an amount for which he is entitled to be given credit, such as returned goods, and allowances.

Creditor—A person to whom money is owing.

Death Duties—Government Tax on the property of a deceased person, on its passing to the successors. Death Duties are levied, under three headings, i.e., Estate Duty, Legacy Duty, and Succession Duty.

Deed—A contract in writing signed, sealed and delivered.

Del Credere Agent—An agent who guarantees to his principal the due payment for goods sold on commission.

Demurrage—A charge made at so much per day for the detention of such things as steamers or railway wagons.

Deposit Receipt—The voucher given by a bank for money lent at interest. Deposit receipts are not transferable. Sums lent on deposit may be made payable on demand or at a stated period. Some banks do not issue deposit receipts but give a pass-book instead.

Dividend—Profits of a company divided among the shareholders. Ex Dividend means that the quoted price does not include the next dividend. Cum Dividend means that the price includes the next dividend. Dividend also refers to the payments out of an insolvent estate.

Factor—One who transacts business for another. He differs from an Agent inasmuch as he trades in his own name when buying or selling goods on behalf of a principal.

I.O.U. (I owe you)—A written acknowledgment of a debt. It does not require a stamp, and is not negotiable. The debt may be sued for.

Interest—The premium paid by a borrower for the loan of money. Simple interest is the amount calculated upon the sum advanced only. Compound interest is calculated both on principal and interest periodically, and is added to the principal instead of being paid to the lender.

Interest on Capital—The amount charged against a business, before distributing profit, for the capital employed.

Invoice—A statement giving description, quantity, and price of goods sold.

Lease—A grant of property, such as land, or buildings, from year to year, or for a term of years, or for life. The consideration may be a premium in advance or an annual rent. The party that grants the lease is the " lessor," the other is termed the " lessee."

Mortgage—A transfer of property as security for money lent, or owing. Interest, at an agreed rate, is payable by the borrower—the " mortgagor "—to the lender—the " mortgagee." The original owner, as a rule, keeps possession of the property during the continuance of the mortgage.

Narration—The particulars explaining a Journal entry.

Premium—(1) The amount paid for insurance. (2) A payment made to an employer on a pupil becoming indentured or articled. (3) The excess of the market value of a security over its nominal or face value.

Quarter Days—England: Lady Day, March 25th; Mid-summer, June 24th; Michaelmas, September 29th; Christmas, December 25th. Scotland: Candlemas, February 2nd; Whitsunday, May 15th; Lammas, August 1st; Martinmas, November 11th.

Receipt—An acknowledgment in writing of the receipt of cash, etc. A receipt for money. If for £2 or upwards, a 2d. stamp (which must be cancelled) is required.

Reconciliation Statement—A statement showing

the agreement of one account with another, such as a bank reconciliation statement.

Reserve Fund—A Fund which is formed by periodically setting aside a share of the profits of a business to meet contingencies.

Voucher—A receipt for cash paid, or any document vouching the accuracy of accounts, etc.

Writing Off (*or Writing Down*)—The term given to the writing down of the book value of assets, or the transferring of a loss to Revenue or Profit and Loss Account. Extinguishing a worthless asset. "Writing up" is to increase the book value of assets when material appreciation has taken place.

Our Author here gives an account of the Single Entry System and illustrates it by a series of examples. He also describes the principles and use of Milk Records and Feeding Stuff Records.

Single Entry Accounts.

It would be wrong to say that there is a complete lack of system when dealing with Accounts under the Single Entry system (although at times it may appear so), for in many cases there are as many books kept in Single Entry as in Double Entry, though people in a small way of business sometimes keep no more than a Ledger.

Real and Nominal Accounts are not opened in the Ledger, and the only items in the Cash Book that are posted to the Ledger are those relating to personal accounts of the debtors and creditors.

The records obtained in Single Entry only provide the business man with amounts due from Debtors, and the amounts due to Creditors. The Cash Book provides a record of the Receipts and Payments and from that the Balance of cash in hand or in the Bank can be ascertained.

However, from these figures it is possible to arrive at a Profit or a Loss by comparing the financial position of one period with that of another period.

Comparisons between the two periods reveal the increase or decrease in Capital. Allowance for any capital withdrawn, or paid in, will represent the gain or loss for the period.

If a Balance Sheet at the beginning of the year showed a capital of £3,000, and a Balance Sheet at the end of the year gave the Capital as £3,100, a profit of £100 would be the result. If however £150 had been withdrawn for Private expenses, the profit for the year would be £100 plus £150, making a total of £250.

To prepare a Profit and Loss Account from this system means that many extracts have to be taken from the Cash Book and this is very often a laborious and tedious task.

Simple System of Accounting.

The Author of this book has prepared a simple book known as the Clansman Farm Account Book*, which is used by many farmers throughout the British Isles. It is designed to meet the requirements of farmers who have no knowledge of Double Entry or any other system of accounting.

The Balance Sheet is specially drawn up so that the amounts given in the valuation are merely entered opposite the items relating to the various departments of the farm, such as Cattle, Horses, Sheep, Crops, and Tillages. The amount of Cash in hand and the amount of Cash in the Bank are entered in their respective columns. Any debts owing to the farmer are entered under Sundry Debtors, and the total of the right-hand side gives the total of the Assets.

Under Liabilities, which are shown on the left-hand side, are entered all the debts owing by the farmer, such as Rent owing to the Landlord, and the amounts owing to the Seeds Merchants or Grain Merchants.

The capital is found by deducting the Liabilities from the Assets.

Account Book.

The Account Book is ruled off in 30 columns which correspond with the various departments of the farm, such as Cattle, Sheep, and Oats, on the Debit side, and Manures, Feeding Stuffs, Wages and so on, on the Credit side. Each cash transaction is entered in the Cash or Bank Column, and then extended to the correct analysis column. Only cash transactions appear in the Analysis Book. Credit transactions ought to be entered at the end of the Book in the space provided for this purpose and for other notes, or in the Farm Diary.

The Analyses Columns separate or analyze the various items in such a way that the totals from the various columns can be compared at the end of the year with similar totals in previous years or with similar totals on other holdings.

Account Book Procedure.

The first entry to be made in the Account Book is the balance of Cash in hand and the Balance of Cash in the Bank, which are both entered on the Debit side. If there is an Overdraft, the entry would be made on the Credit side and the amount would be preceded by the words " By Balance."

If a cheque is received and paid into the Bank for Cattle sold, the amount is entered in the Bank Column on the Debit side and extended to the Cattle Column on the same side.

When cheques are received it is not always convenient to pay them into the Bank and in such cases they are placed in the Cash Box and the Cash Column is debited, and the extension is made as before.

As soon as the cheques are taken from the Cash Box and paid into the Bank, the Cash Column is credited and the Bank Column is debited. The words " By Bank (paid in) " are written on the Credit side and the words " To Cash (lodged) " appear on the Debit side.

A cheque for £200 has been received for Sheep sold. The £200 is entered in the Cash Column, preceded by the words " To Auction Mart," and the £200 is extended to the Sheep Column.

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* CLANSMAN FARM ACCOUNT BOOK.

This book is simple and complete. It meets Income Tax and other requirements. Copies can be obtained from the author, A. C. Campbell, lecturer in Agriculture and Farm Accounts, Harper Adams Agricultural College, Newport, Shropshire. Price 13/6 post free.

Two days later the cheque is paid into the Bank. The £200 is entered in the Cash Column on the Credit side as having been paid out of the Cash Box. The £200 is entered in the Bank Column on the Debit side as the Bank has received this amount.

One hundred and fifty pounds is paid by cheque for the Rent. The date is entered and the words " By Rent " written in the Particulars Column on the Credit side. The £150 is entered in the Bank Column and this amount is extended to the Rent Column.

Three pounds is taken from the Cash Box to pay general expenses. " By Market expenses " or " By Stationery " is written in the Particulars column and the £3 is shown in the Cash Column and extended to the General Expenses Column on the Credit side.

Supposing £10 is drawn from the Bank to be placed in the Cash Box. The Bank would be credited and the Cash debited. " By Cash " would be written on the Credit side and the £10 entered in the Bank Column. The £10 would then be entered in the Cash Column on the Debit side to show that it has gone into the Cash Box and the words " To Bank (cash drawn) " written in the column headed Particulars.

Balancing the Account Book.

The more frequently the Account Book is balanced the greater the efficiency and the greater the time-saving of the person closing the Accounts at the end of the year. It may be advisable therefore to make a Balance at the bottom of each page or at the end of the week or month.

Supposing the Cash Column on the Debit side is totalled and is found to read " £200," and the Total of the Cash Column on the other side amounts to £190, the Balance will be £10. If there is not £10 in the Cash Box it will be necessary to investigate the discrepancy.

Similar procedure is adopted when balancing the Bank Columns. If the total of the debit column is £4,950, and the total of the Credit Bank Column is £4,000, the Balance in the Bank will be £950. There are two possibilities of discrepancy arising in the Banking transactions. First, there is the possibility of making wrong entries or of omitting to enter transactions that have been made at various times. These differences can often be discovered by checking the Bank receipts and payments with the receipts and payments in the Pass Book.

The second possibility of a difference is found where cheques are paid and have not been presented to the Bank and are therefore not recorded in the Pass Book. Or there is the probability that cheques received and paid into the Bank by the farmer have not been collected, and consequently are not seen in the Pass Book. Bank charges are often entered in the Bank Pass Book and these have to be recorded in the Bank Column in the Account Book before striking a Balance.

Seldom in business does the Bank Pass Book balance with the Bank Columns in the Account Book and the Accounts have to be reconciled.

Supposing the Balance in the Bank Column showed that there was a balance of £10 in the Bank and the Pass Book Balance was an Overdraft of £10. The difference could be due to a cheque for £30 having been paid by the farmer and not presented, which would increase the Overdraft to £40, and to two cheques valued £50 received by the farmer and not yet collected:

$$-£10 \text{ and } £30 = -£40 + £50 = +£10.$$

To Cheques received and not collected ..	£50	By Balance	£10
		,, Cheque not presented	30
		,, Balance	10
			£50

The following example will show how a list of simple transactions is written up and balanced in the Clansman Farm Account Book. It will also show the preparation of the Profit and Loss Account and Balance Sheet at the end of the year.

These are the particulars of A. Kerr, Barr Farm, kept in the above Account Book. He wants a Profit and Loss Account, and a Balance Sheet for the financial year ending September 29th, 1949.

On September 29th, 1948, he had cash in hand £40, and in the Bank, £960. His valuation showed Corn, Hay and Straw at £600, Implements £480, Growing Crops £260, Horses £200, Cattle £400, Pigs £15. He owed J. Crowe £50. F. Dunn owed him £20, and S. Farr owed him £30.

His transactions for the year were as follows:—

1948					
Oct.	13	He sold Seed Oats to G. Howes	£360	0	0
Dec.	24	Bought from R. Walls, Feeding Stuffs	90	0	0
1949					
Feb.	28	Sold Wheat to M. Tapley for cash	380	0	0
Mar.	3	Received Cheque from G. Howes	360	0	0
,,	7	Paid Cash into Bank ..	740	0	0
,,	27	Bought Seeds from A. Clucas	28	0	0
April	4	Paid half-year's Rent by cheque	130	0	0
July	23	Sold Cattle and received cheque	360	0	0
,,	27	Sold Milk and Eggs for cash	70	0	0

Date		Particulars	Amount
1949			
Aug.	2	Bought Horse and paid cheque	£80 0 0
,,	2	Paid General Expenses ..	10 0 0
,,	2	Paid Clucas by cheque ..	26 12 0
,,	2	Was allowed Discount ..	1 8 0
,,	26	Sold Cattle and received cheque	200 0 0
,,	27	Purchased Cattle and paid cheque	280 0 0
Sept.	1	Paid Cash into bank.. ..	600 0 0
,,	1	Paid Private Expenses cash ..	50 0 0
,,	13	Paid R. Walls by cheque ..	85 10 0
,,	13	He allowed Discount ..	4 10 0
,,	24	Sold Wheat to Mr. Tapley ..	330 0 0
,,	25	Bought Cattle and paid by cheque	500 0 0
,,	26	Sold Cattle to B. Dealer ..	370 0 0
,,	28	Paid cheque for Insurance ..	20 0 0

Date		Particulars	Amount
1949			
Sept.	28	Drew Cash for Wages during year	£750 0 0
,,	29	Received Share Dividends valued	50 15 0
,,	29	Paid Private Expenses ..	100 0 0
,,	29	Half-year's Rent due ..	130 0 0
		Allow 15 per cent for Depreciation of Implements.	
		Value of Farm Produce consumed by the Farmer's Household	40 0 0
		Valuations: Corn, Hay and Straw ..	860 0 0
		Growing Crops ..	340 0 0
		Cattle	460 0 0
		Pigs	20 0 0
		Horses	280 0 0

BALANCE SHEET OF THE FARM OF A. KERR, BARR FARM,

29th SEPTEMBER, 1948

LIABILITIES	£ s. d.	ASSETS	£ s. d.
Sundry Credtors (Debts payable by Farmer, ...	50 0 0	Cash in hand	40 0 0
Capital (Excess of Assets over Liabilities)	2,955 0 0	Cash in Bank	960 0 0
		Cattle	400 0 0
		Horses	200 0 0
		Pigs and Poultry	15 0 0
		Hay and Straw (and Corn)	600 0 0
		Growing Crops	260 0 0
		Implements and Machinery	480 0 0
		Sundry Debtors (Accounts Receivable by Farmer)	50 0 0
	£3,005 0 0		£3,005 0 0

PROFIT AND LOSS ACCOUNT OF BARR FARM,

FOR YEAR TO 29th SEPTEMBER, 1949

	£ s. d.		£ s. d.
Valuation of Stock at beginning of year	1,955 0 0	Valuation of Stock, at end of year ..	2,368 0 0
Cattle	780 0 0	Cattle	560 0 0
Seeds	26 12 0	Oats	360 0 0
Feeding Stuffs	85 10 0	Wheat	380 0 0
Rent, Taxes and Insurance	150 0 0	Milk	70 0 0
Wages	750 0 0		
Other Payments..	80 0 0		
General Expenses	10 0 0		
	3,837 2 0		3,738 0 0
Add—Debts Payable at end of year ..	180 0 0	*Add*—Debts Receivable at end of year	750 0 0
	4,017 2 0		4,488 0 0
Deduct—Debts Payable at beginning of year	50 0 0	*Deduct*—Debts Receivable at beginning of year	50 0 0
	3,967 2 0		4,438 0 0
Add—Value of Boarding of Farm Workers		*Add*—Value of Produce Consumed by Household	40 0 0
Balance being Net Profit	510 18 0	Balance being Net Loss	
	£4,478 0 0		£4,478 0 0

RECEIPTS

Date 1942	Name and Particulars	Cash	Bank	Cattle	Oats	Wheat	Milk	Private Income			
ept. 29	To Balance	40 0 0	960 0 0								
1943											
eb. 28	Tapley. Wheat Sold...	380 0 0				380 0 0					
ar. 3	G. Howes. Seed, Oats	360 0 0			360 0 0						
7	Cash—Lodged		740 0 0								
ly 23	Cattle	360 0 0		360 0 0							
27	Milk and Eggs ...	70 0 0					70 0 0				
ug. 26	Cattle	200 0 0		200 0 0							
pt. 1	Cash—Lodged ...		600 0 0								
29	Private Account ...		50 15 0					50 15 0			
		£1,410 0 0	£2,350 10 0	£560 0 0	£360 0 0	£380 0 0	£70 0 0	£50 15 0			
	Carried Forward ... £										

PAYMENTS

Date 1943	Name and Particulars	Cash	Bank	Cattle	Seeds	Feeding Stuffs	Rent, Taxes and Insurance	Wages	Other Payments	General Expenses	Private and Household Payments Income Tax
ar. 7	By Bank—Paid in ...	740 0 0									
pr. 4	Rent		130 0 0				130 0 0				
ug. 2	Horse—bought ...		80 0 0						80 0 0		
2	General Expenses ...	10 0 0								10 0 0	
2	Clucas—Seeds ...		26 12 0		26 12 0						
27	Cattle (bought) ...		280 0 0	280 0 0							
ept. 1	Bank—Paid in	600 0 0									
1	Private Expenses ...	50 0 0									50 0 0
13	R. Walls		85 10 0			85 10 0					
25	Cattle Bought		500 0 0	500 0 0							
28	Insurance		20 0 0				20 0 0				
28	Wages for year ...		750 0 0					750 0 0			
29	Private Expenses ...		100 0 0								100 0 0
	By Balance ...	10 0 0	378 13 0								
		£1,410 0 0	£2,350 15 0	£780 0 0	£26 12 0	£85 10 0	£150 0 0	£750 0 0	£80 0 0	£10 0 0	£150 0 0
	Carried Forward ... £										

BALANCE SHEET OF BARR FARM
FOR YEAR TO 29th SEPTEMBER, 1949.

LIABILITIES	£ s. d.	ASSETS	£ s. d.
Sundry Creditors (Debts payable by Farmer)	180 0 0	Cash in Hand	10 0 0
Capital (Excess of Assets over Liabilities)	3,326 13 0	Cash in Bank	378 13 0
		Cattle	460 0 0
		Horses	280 0 0
		Pigs and Poultry	20 0 0
		Hay and Straw (and Corn)	860 0 0
		Growing Crops	340 0 0
		Implements and Machinery	408 0 0
		Sundry Debtors (Accounts Receivable by Farmer)	750 0 0
	£3,506 13 0		£3,506 13 0

Check

Private Payments	£150 0 0	Capital at beginning of year	£2,955 0 0
Value of Food Consumed by Household	40 0 0	Profit	510 18 0
Balance	3,326 13 0	Private Receipts	50 15 0
	£3,516 13 0		£3,516 13 0

By making a start on 29th September, 1948, it will be seen that a Balance Sheet was prepared, showing assets amounting to £3,005. The total liabilities amounted to £50, which left a Capital of £2,955.

On 13th October, Seeds Oats were sold to G. Howes on credit, and record of this was entered at the end of the Book. Another credit transaction with R. Walls, for Feeding Stuffs, on December 24th, was also recorded at the end of the Book.

On February 28th, Wheat was sold to Tapley, for cash. The Cash Column was debited with £380, and the £380 was extended to the Wheat Column.

G. Howes sent his cheque on March 3rd, for £360. The £360 was entered in the Cash Column, and extended to the Oats Column. The transaction was also struck out at the end of the Book as the Account was settled.

On March 7th the Bank Column was debited because it received £740. The Cash Column was credited because the £740 went out of the Cash Box.

It was recorded at the end of the Book on March 29th that Seeds were purchased on credit from A. Clucas, for £28.

£130 was entered in the Bank Column on April 4th, as the account was paid by cheque, and the £130 was extended to the Rent Column.

July 23rd showed an entry of £360 in the Cash Column for cattle sold and the cheque was placed into the Cash Box.

£70 was entered in the Cash Column and extended to the Milk Column on July 27th.

£80 entered in the Bank Column when the Horse was bought and paid for by cheque on August 2nd. It was also shown in other payments.

On August 2nd, £10 was entered in the Cash Column and carried to the General Expenses Column as a payment.

£26 12s. 0d. was entered in the Bank Payment Column and extended to the Seeds Column on August 2nd. The transaction was stroked out at the end of the Book.

August 26th. The same as July 23rd.

August 27th. Entered £280 in the Bank Column and extended the amount to the Cattle Column.

September 1st. The same as March 7th.

£50 was shown in the Cash Column on September 1st, and extended to the Private Column.

Entered on September 13th, £85 10s. in the Bank Column, and extended the amount to the Feeding Stuffs Column. Also stroked the transaction off at the end of the Book as being settled.

September 24th. The same as October 13th.

The £500 paid on September 25th. The same as August 27th.

September 26th. Made a note at the end of the Book of the Cattle credit transaction with B. Dealer.

Made an entry in the payment Bank Column of £20 on September 28th, and extended the amount to the Insurance column.

September 28th. Entered £750 in the Bank Column and extended it to Wages.

If a sum of £30 is drawn from the Bank each fortnight for Wages, it may be entered in the Payments Bank Column, and in the Receipts Cash Column. Then when the Wages are paid out of the Cash Box, the amount can be entered in the Payments Cash Column and extended to the Wages Column.

September 29th. Entered £50 15s. in the

Receipts Bank Column and extended it to the Private Column.

September 29th. Made an entry at the end of the Book that £130 was owing to the Landlord.

Reduced the Value of the Implements to £408.

Entered £40 for Farm Produce consumed in the household in the Profit and Loss Account and in the *Check at the end of the year.*

Profit and Loss Account.

Entered the total of the valuation at the beginning of the year on the Debit side (left).

Entered the Payments for Cattle, Seeds, Feeding Stuffs, Rent, Wages, other payments and General Expenses in their respective columns.

Entered Debts payable from the end of the Book.

Entered Debts payable at the beginning of the year from the Opening Balance Sheet.

On the right-hand side of the Profit and Loss Account entered the Valuation at the end of the year.

Entered the Receipts in the Columns named.

Balance Sheet.

Entered the Assets and Liabilities. Totalled, and found the Capital, £3,326 13s.

Check.

When the Balance of the Check agrees with Capital in the Balance Sheet, the Books are said to be checked.

Milk Records and Feeding Stuffs Records.

A combination of milk records and feeding stuffs records gives the farmer an excellent opportunity to check the yields of milk over the amount of feeding stuffs required to produce these yields.

Assumed that the dairy herd produces 40,000 gallons of milk in the house. It is generally accepted that $2\frac{1}{2}$ pounds of starch equivalent, and $\frac{1}{2}$ pound of protein are required to produce a gallon of milk. This is usually obtained from $3\frac{1}{2}$ pounds of feeding stuffs.

The amount of feeding stuffs required will be $(40{,}000 \times 3\frac{1}{2})$ lb. If the amount of foods used exceeds these quantities, steps can be taken to make the necessary adjustments.

In all probability the amounts of food are divided into two parts of cereals and one part of protein.

Again there can be a check on the cereals and on the protein cakes that are fed.

If half the milk is produced in the house and the other half on the grass approximately half the amounts of cereals and proteins is required. The necessary allowances, of course, are made for the management of the cows during the pasturing periods.

If three-quarters of the milk is produced in the house then the quantities of cereals and proteins are three-quarters of the original amount.

The figures are only approximations, but when the amount of wastage that has taken place on a wholesale scale is considered, the milk and food records, together with the checks, are to be recommended to farmers and farm managers.

Although the figures referred to are approximate figures, there is no reason why they should not be reduced to exactness.

Records showed that a cow yielded 300 gallons when milk was selling at 6d. per gallon. She was returning 300 × 6d. = £7 10s., which meant that careful management was needed to make the animal show a profit.

How many cows did not pay their way when milk was sold at 6d. per gallon, and what was the average yield per cow in England when milk was selling at that price?

When accounts showed that the actual amount laid out in keeping a herd of 35 cows was £500, it meant that the cost of milk from each cow was $\frac{£500}{£35} = £14$ 6s., or 3,432d.

How many gallons of milk did a cow have to produce to pay her way at 6d. per gallon? $\frac{3{,}432}{6} = 572$ gallons.

How many cows paid their way? How many cows showed a profit? How many cows lived at the expense of other cows in the herd? The accounts and records gave the answers.

Accounts have shown that the figure in a 40 cow herd, making allowances for calf and other sales amounted to £1,040. The cost per cow was $\frac{£1{,}040}{£40} = £26$ or 520/–.

It is seen that with milk at 1s. per gallon, the herd had to average 520 gallons per annum to pay its way.

On the many farms, problems like these would have demanded investigations.

Having illustrated the principles of storing papers and documents in what is known as Filing, the author sets out tables of useful weights and measures. He shews us how to make certain important measurements and computations on the farm, points of some difficulty in practice but here clearly set out so that even a beginner can understand them. Costings are explained and illustrated by examples. The subject of Valuations is opened and the relation of Financial Account to Farm Management is dealt with in some detail. Local custom in different counties is explained.

Filing.

It is necessary for the saving of time, to devise some system for dealing with the storage of papers and documents so that they can be produced when required and afterwards be returned to their proper places. The heap of papers, consisting of Invoices, Accounts, Letters and Leaflets, that so often gives a farmer a two-day hunt to find a particular paper, ought to be reduced to some sort of order.

Although there are many excellent filing systems on the market at different prices, it is possible to distribute papers into compartments practically without cost.

A very simple method of dealing with numerous Invoices is to take a piece of stiff brown paper and fold it in two so that it opens like a book. Four of these, which may be termed "*files*," will readily receive the Invoices of the ordinary farm. They can be lettered A to G, H to N, O to S, and T to Z.

Black's Invoice will be found in the first file, and since the Invoices will be preserved alphabetically, all Black's Invoices will be grouped together.

At the end of the year the Invoices are removed from the Files and wrapped up in one parcel. The Files can again be used for the next year.

Accounts and Receipts.

When Accounts are received they ought to be placed in a File or in a pigeon hole in the writing desk. As soon as the Account is settled, the Receipt ought to be placed in a special File for Receipts and as it will be placed in order of date, reference can be made to it at any time, the File for the Receipts can be designed on the same principle as the File used for Invoices.

Letters.

Many Letter Filling Systems are on the market, but since it is possible to deal with Invoices and Receipts in a simple way there is no reason why letters should not be dealt with in a similar manner.

If there is not much letter-writing, one file may be sufficient. If not, two, three or four files can be used.

A letter is received from Craig. A copy of the reply is placed beside it and both are put into the First File. If another letter is received from Craig it is dealt with as before and if the correspondence is continued for six months, it is possible for the farmer to locate any letter, of any date, and the reply, in a few seconds.

The letters can be removed from the Files at the end of the year and parcelled for storage.

Table Measurements.

Farm Management calls for a knowledge of the Tables of Weights and Measures and of Area Measurements and other standards.

Casual workers and piece-time work are on the increase, and the Farm Manager is expected to be able to estimate the cost of certain work and to be able to check and measure the work when it is completed.

Thinning turnips, mangolds and sugar beet by piecework must be measured. Hedging, Ditching and Draining are other examples of the measurements that have to be made from time to time.

Spreading Farm Yard Manure and even carting the manure are done on piece-work.

Topping and tailing roots, lifting potatoes and sugar beet and numerous other operations are included in this Contract category.

Measurements of ploughing, cultivating and other tillage operations have to be calculated. Growing crops have to be measured and calculations made to their values. Potato clamps or pits have to be measured and valued. The contents of hay-ricks and corn stacks have frequently to be submitted, as well as Farm yard manure measurements for purposes of valuation.

	WEIGHT (Avoirdupois)	
16 drams	=	1 ounce (oz.)
16 oz.	=	1 pound (lb.)
14 lb.	=	1 stone (st.)
28 lb.	=	1 quarter (qr.)
4 qr.	=	1 hundredweight (cwt.)
20 cwt.	=	1 ton
	LENGTH	
12 inches	=	1 foot (ft.)
3 ft.	=	1 yard (yd.)
5½ yd.	=	1 rod, pole or perch
40 poles	=	1 furlong
8 furlongs	=	1 mile
or 1760 yd.	=	1 mile
	AREA	
144 sq. in.	=	1 sq. ft.
9 sq. ft.	=	1 sq. yd.
30¼ sq. yd.	=	1 sq. pole
40 sq. poles	=	1 rood
4 roods	=	1 acre
or 4840 sq. yd.	=	1 acre
640 acres	=	1 sq. mile
	CAPACITY	
4 gills	=	1 pint (pt.)
2 pt.	=	1 quart (qt.)
4 qt.	=	1 gallon (gal.)
2 gal.	=	1 peck (pk.)
4 pk.	=	1 bushel (bus.)
8 bus.	=	1 quarter (qr.)

Other measures used in the sale of Corn.

Coomb of 4 bushels.
Sack of 4 bushels.
Boll of 6 bushels at Berwick.
Boll of 4 bushels at most places in Scotland.

Corn is quoted at either so much the quarter or per bushel, but it is actually sold by weight.

	Wheat	*Barley*	*Oats*
Bushel	63 lb.	56 lb.	42 lb.
	4½ stones	4 stones	3 stones
Sack = 4 bushels ..	18 stones	16 stones	12 stones
Quarter = 2 sacks or 8 bushels	36 stones	32 stones	24 stones

IMPERIAL SQUARE MEASURE

144 square inches	=	1 sq. foot
9 square feet	=	1 sq. yard
30¼ square yards	=	1 sq. pole
40 square poles	=	1 rood
4 roods	=	1 acre
640 acres	=	1 sq. mile
43,560 sq. feet	=	1 acre
4,840 sq. yards	=	1 acre
160 sq. rods	=	1 acre
10 sq. chains	=	1 acre

SOLID MEASURE

1728 cubic inches	=	1 cub. foot
27 cubic feet	=	1 cub. yard

HAY AND STRAW

36 lb. of straw	=	1 truss
56 lb. of old hay	=	1 truss
60 lb. of new hay	=	1 truss
36 trusses	=	1 load

Area of Retangular Figures.

Area of a Rectangle.

A rectangle is a four-sided figure with each of its angles a right-angle. The area will be obtained by multiplying its length by its breadth.

A rectangular piece of ground measures 26 chains 16 links by 21 chains 80 links. What rent should be paid at £1 6s. 3d. per acre?

Length	.. ..	26·16 chains.
Breadth	.. ..	21·80 chains.
Area	.. ..	26·16 × 21·80.

Since 10 sq. chains = 1 acre.

$$\text{Area} = \frac{26{\cdot}16 \times 21{\cdot}80}{10}$$

= 57·0288 acres.

Cost = 57·0288 × £1 6s. 3d.
= £74 17s. 0d.

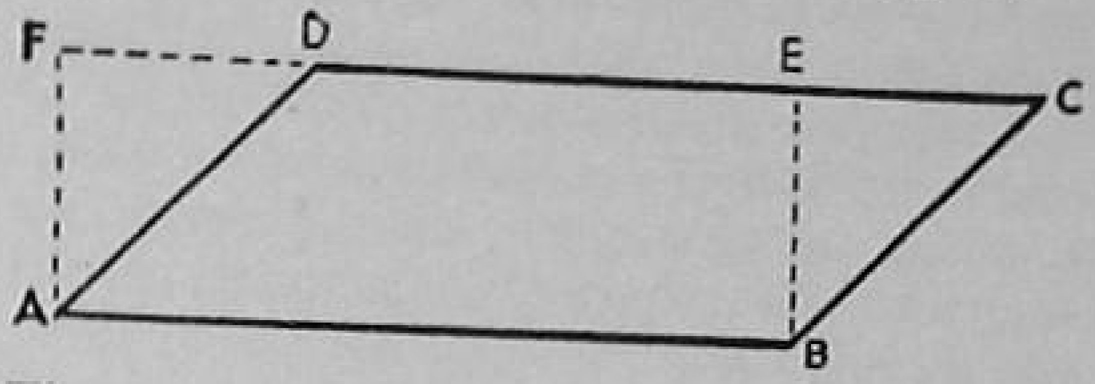
or

$$\frac{26{\cdot}16 \times 21{\cdot}80}{10} \times £1{\cdot}3125.$$

= £74 17s. 0d.

Area of a Parallelogram.

A Parallelogram is a four-sided figure with its opposite sides parallel, and of course equal.

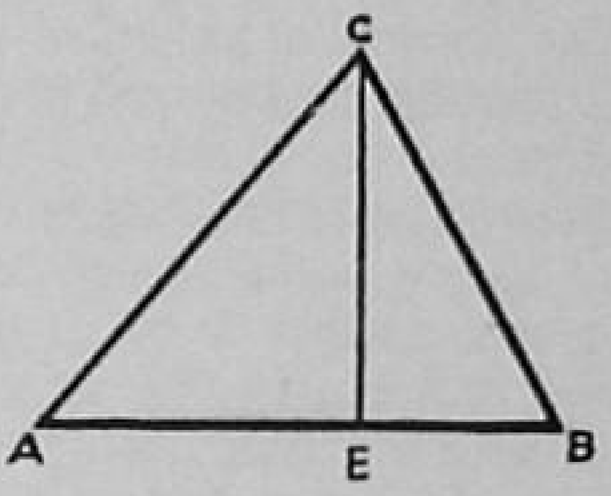


The area of a parallelogram = base × perpendicular height.
= AB × BE

A field is in the shape of a parallelogram. The length of the base is 8 chains 45 links, and the perpendicular distance between the sides is 4 chains 16 links.

Area = base × perpendicular height.
= 8·45 × 4·16.
= 35·16 sq. chains.
= 3 acres 2 roods 2½ poles.

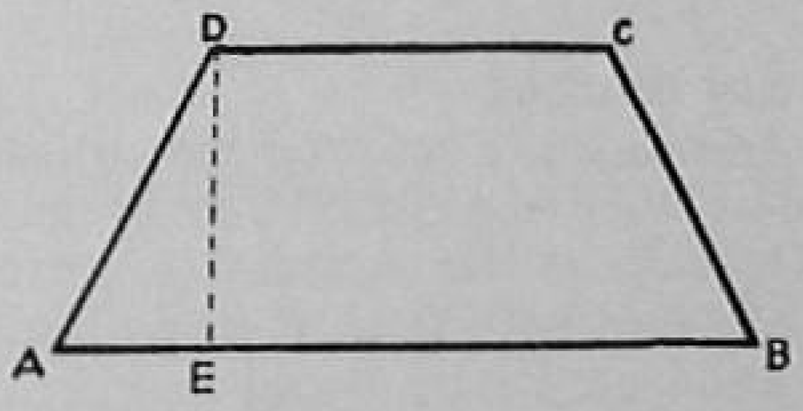
Area of a Triangle.



The area of a triangle
= ½ base × perpendicular height.
= ½ AB × CE.

Area of a Trapezium.

A Trapezium is a four-sides figure with no more than two of its sides parallel.



The area of a trapezium = half the height multiplied by the sum of the parallel sides.
= ½DE × AB + DC.

Mangels and Swedes Clamps.

The volume of the Clamp is

$$\frac{\text{length} \times \text{width} \times \text{height}}{2}$$

The length is taken one-third of the way up the slope of the clamp.

Make allowance for the covering of straw and soil. An average weight of Mangels and Swedes is 1 ton to 61 cubic feet.

A Mangel Clamp 124 ft. long, 9 ft. 6 ins. wide and 4 ft. high.

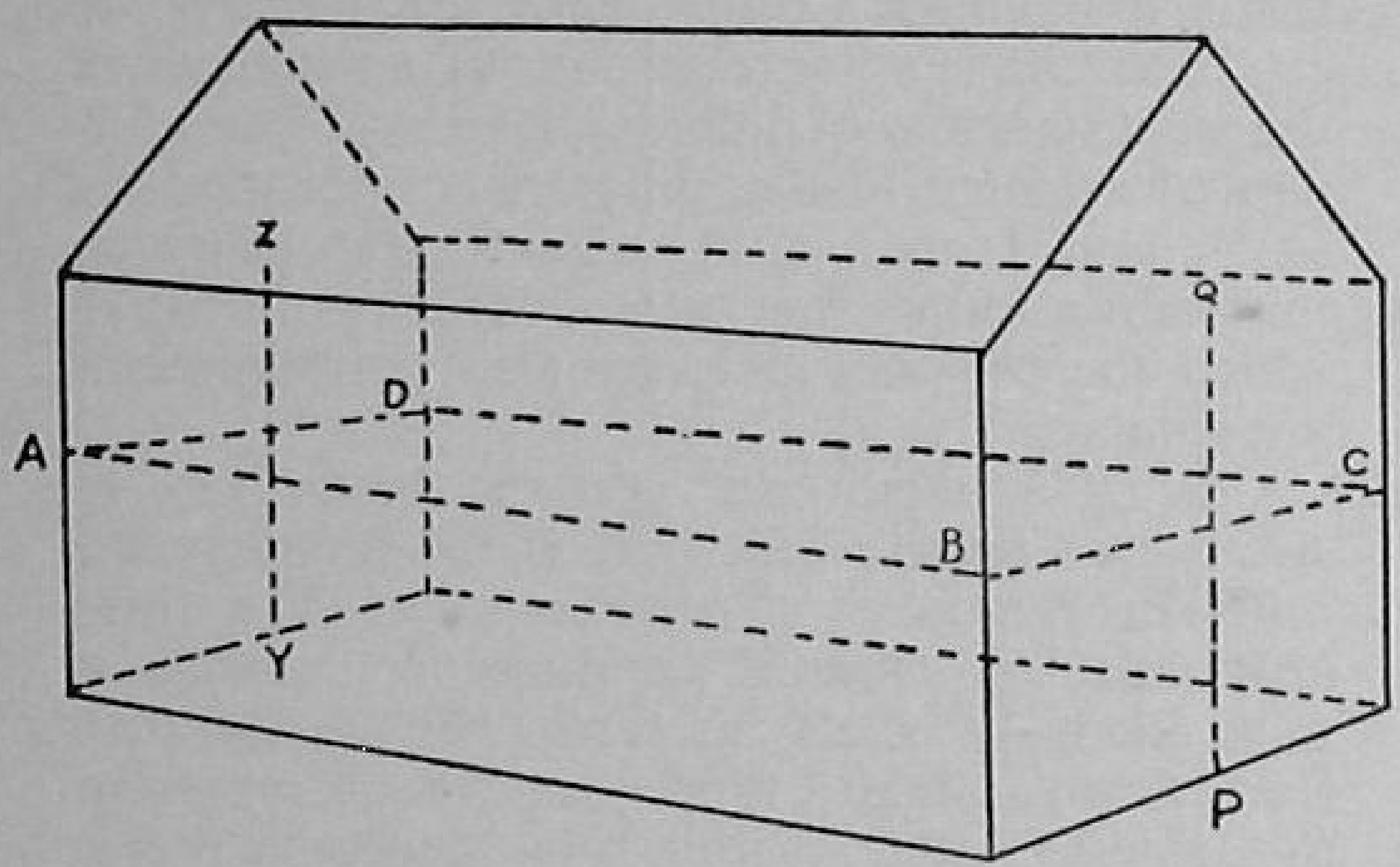
$$\text{Volume } \frac{124 \times 9{\cdot}6 \times 4}{2} = \text{cubic feet.}$$

Estimated number of tons in Clamp:

$$\frac{124 \times 9{\cdot}6 \times 4}{2 \times 61} = 38\tfrac{1}{2} \text{ tons.}$$

VOLUME OF STACKS.

Stacks of white crop, hay and straw, have to be measured and the sketch gives a rough indication of how to make the measurement. The result will give the cubic contents, and from that the weight of the material in the stack can be found. It is advisable to confine the measurements to good solid materials, and to exclude the long loose material, bottoms and thatching from the calculation.



Measure A to B	= 30 ft.	
Measure C to D	= 32 ft.	
Add	= 62 ft.	
Divide by 2 = 31 ft.	= Average length of stack.	
Measure B to C	= 16½ ft.	
Measure D to A	= 17½ ft.	
Add	= 34 ft.	
Divide by 2 = 17ft.	= Average width of stack.	

Take the above measurements at a point half-way up the Stack.

Measure P to Q	= 11 ft.
Measure Y to Z	= 12 ft.
Add	23 ft.
Divide by 2	= 11½ ft. Average height of Stack.

If the ends of the top are upright, the height PQ, and Y to Z should be measured to about one-third the distance between the eaves and top of the stack. If the ends of the roof slope, these measurements should be taken up to one-quarter of the distance between the eaves and top of the stack. Since we have obtained the average length, width, and height of the stack we then multiply them together, 31 × 17 × 11½, and the result gives us (in cubic feet) the cubic contents of the Stack.

The quantity of produce contained in the stack will depend upon the crop of which the stack is built.

Grain.

The quantity and value of the grain in its natural state is a little difficult to estimate, and wherever it is possible the valuation is better left until the grain is threshed. However, if a valuation has to be made before threshing, the following notes will act as a guide and the figures should be well checked.

The farmer must use his judgment as he knows whether the stack has been built, loosely or tightly, and whether in threshing the grain is likely to run well or badly. The following figures will act as a guide in average cases.

Oats	.. 1	bushel	of grain	from	each	18	cubic feet.
Barley	.. 1	,,	,,	,,	,,	22	,,
Wheat	.. 1	,,	,,	,,	,,	27	,,
Beans	.. 1	,,	,,	,,	,	35	,,
Peas	.. 1	,,	,,	,,	,,	36	,,

Straw.

As in the grain, variation are also seen in the weight of straw built in the stack. Straw after threshing of course takes up more room than straw tied in the sheaf. Apart from the tightness in the building, wheat-straw takes up less room, ton for ton, than oat or barley straw, or even pea or bean straw.

As a rough guide in arriving at approximate estimations, the following figures are given:—

Wheat Straw	..1	cwt.	of straw	from	each	27	cubic ft.
Oats Straw	..1	,,	,,	,,	,,	33	,,
Barley Straw	..1	,,	,,	,,	,,	40	,,
Pea Straw	..1	,,	,,	,,	,,	46	,,
Bean Straw	..1	,,	,,	,,	,,	40	,,

Hay in the stack can be dealt with much in the same way as straw, as the tightness of the building, and the quality and nature of the crop affect the weight. Generally it is light in the stack if it is cut late or made from rough grass and harvested in very dry condition. Hay made from fine meadow grasses is usually heavy especially in the south, where it is allowed to sweat in the stack. The density of the stack is usually judged by the size (the bigger it is the more solid it is), and from a knowledge of the crop and how it was harvested. Average stacks might show that 1 cwt. of hay was loaded from each 14 cubic feet of meadow hay as 1st cut Seeds hay, and that 1 cwt. was taken from each 18 cubic feet of 2nd cut Seeds hay.

COSTINGS.

The precise determination of costs, as seen in the industrial factory, cannot be expected on the farm. The individual costs of products, and the separation of profits and losses in the many branches of the farm, present a greater number of complications than are found in most other industries.

Any system of costing for the use of the farmer himself must be relatively simple in form and in method.

Costing Schemes can scarcely be looked upon as being the work of the farmer. He is, however, in the position when compiling his financial accounts to collect the data necessary for such schemes. Those data, if passed on to the advisory costing centres, can be used in the interest of the farmer or his district, or even in the interest of the country as a whole.

The general procedure is to collect data relating to hours of work, the number of men in the holding, horses and tractors used, the quantities of raw materials purchased and used, acreages of crops grown, the number of stock purchased and sold, and the yields of produce obtained.

A costing scheme is based on the policy of the farm with a view to making changes or improvements without upsetting the Balance of Farming.

Good farming is a balance of stock, crop, fertility, and the improvement and maintenance of the Stock. Each farm product is really a joint product and to cost that product the whole of the farm has usually to be costed.

King states that the precision with which a farmer can compare cost and return will depend firstly upon the extent to which his results are under control. It will also be dependent upon weather and other uncertain factors, and upon the importance of the indirect effects of any change of policy. These indirect effects may have to be the subject of estimate in the first instance, and adjustments of practice be made on a system of trial and error.

It is generally accepted that most costs must be collected over a period of years, if normal costs are to be obtained.

Labour and other costs of operations can only be used satisfactorily for comparison of efficiency of labour, or of management, where conditions are similar and other factors are under control.

It might not be correct to state that a uniform basis of apportionment of costs between two or more joint products under different farming systems, would give rise to costs of resultant products which are comparable with one another.

The same observation might be made with initial and residual values of foods and manures under different farming systems.

A study of the dependence of farming upon its natural environment often leads to the conclusion that cost accounts are of value to the individual farmer. The accounts afford a means of examining critically, and in detail, the organization of his farm. They provide a means of estimating the effects, upon his profits, of adjustments which do not disturb the general scheme of his farming. Alternative ways of attaining of some end within that scheme may be available to him. Power, for example, may be provided in different ways. There may be alternative methods of maintaining fertility. Crops, of which the function within the farming system is the same, may replace one another. The grassland may be made to carry different classes of stock. The line of procedure in such cases is to compute the expenses which are peculiar to each of the alternatives open to the farmer, for comparison with the results. Costing for these directly practical ends is relatively simple. Because it only requires the keeping of such records of cash, labour, foodstuffs and yields as are suggested by business procedure, the work is within the powers of the larger number of farmers.

The farming community would be greatly assisted in making decisions involving larger changes of policy if comparative results could be made available. Comparisons are required to establish the relative economy of enterprises of different sizes and of different degrees of intensiveness of working, also of different combinations of stock and crops. Comparisons are, however, misleading unless they are confined to farms of which the physical and economic environments are similar.

Costing schemes are perhaps better left to Advisory Centres, which are to be found in the different provinces of the country. The farm economist or whoever conducts the scheme is most likely to select his farms for comparative study from standard type farms which represent the largest numbers within their respective areas. The Accounts of the farms can then be grouped upon a natural basis, and within each main division. Outlays can be classified as to whether they have a relationship to the enterprise as a whole, or are dependent upon the development of some specific activity within the enterprise.

The object of bringing outlays and returns into relation with one another, is to show the effective cost of carrying out the functions involved in maintaining the farm as a working unit. The returns on crops and stock can then be interpreted in proper relationships to one another.

Comparison between farms will then arise with respect to the amount of the overhead expenses. Observations can be made on the surpluses earned on specific products. The costs of single, combined and complementary processes can be examined under the conditions prevailing.

Cost accounting cannot, for the practical farmer, take the place of well-kept financial accounts. It may well repay the farmer who is interested in figures to attempt a complete

allocation of his farm expenses. He may prefer, however, to pass his figures on to the Advisory Economist in his area.

Farmers' representative bodies and others responsible for the guidance of the industry and for making decisions which affect the farming community are almost obliged to make a study of comparative costs and returns.

Certain Committees draw up Rules for the guidance of Agricultural Accountants. These Rules are made with a view to securing uniformity in the principles underlying comparative costs. The Rent and Rates of Cottages, for example, are usually charged to Labour Accounts. The Rent and Rates of Farm Houses should be charged in the first instance as a business expense against profits. Adjustments can be made later if, and when, necessary. The rent of land should be distributed over a holding at a flat rate per acre.

Where roots are fed on the fields the proportionate share of rent and certain overhead charges are charged to the stock eating the roots. In the case of catch crops the proportion of rent and rates should be two-thirds for the main crop and one-third for the catch crop.

Interest on capital and management charges should not be brought into the accounts except where cash is actually paid.

Produce both grown and used on the farm, e.g., homegrown foods fed to stock and seed should be charged in the accounts at the cost of production, and not at conventional market prices.

The cost of dung should be ascertained, so that it can be charged to the crop accounts. The cost of straw is taken as one-seventh of the cost of production of the oats, barley and wheat crop.

With cleaning crops 75 per cent of the cost of cleaning operations in certain cases is charged to the crop—and the 25 per cent is spread over three years. In the case of turnips and mangolds that are carted, one-third of the cost of cleaning operations should be regarded as removed and two-thirds to be carried forward.

The initial cost of seeds leys should be equally divided between each year over the contemplated length of the ley. When the first crop is fed to sheep, and the second crop cut for hay, or vice versa, the proportion of cost should be two-thirds for the first crop, and one-third for the second crop.

When allocating charges of grazing, four-fifths of the cost should be allocated to the summer period and one-fifth to the winter grazing.

Horse labour should be charged at a flat rate throughout the year.

Cash Accounts are based on Double Entry Accounting. Perhaps one of the simplest illustrations of costing is to be seen where a farmer purchased 10 store cattle at £20 each and grazed them on 10 acres of land rented at £3 per acre on the usual Grass Park Grazing terms.

CATTLE ACCOUNT

Dr.			Cr.
To Bank	£200	By Valuation	£230
„ Bank Rent	30		
	£230		£230

The cost as seen from the Cattle Account is £230 for 10 cattle or £23 each. If wages were paid for the management of the cattle they would be included in the Cattle Account.

The valuation of cattle of this type is based on the cost of production. The Market Value might be £220 or £240. If sold the cattle might realize £250. This simple example illustrates cost of production, market value, and price.

Greater complications are encountered when a branch unit of the farm is costed, because the whole of the farm comes into the scheme.

AVERAGE COST OF HORSE LABOUR

Foods Purchased	£5 18 10
Home Grown	19 19 2
Grazing	2 5 10
Total Foods	£28 3 10
Less Manure	3 16 9
	£24 7 1
Depreciation	5 3 8
Other Items—	
Manual Labour	£0 11 7
Shoeing	2 16 9
Harness Repairs	1 14 8
Equipment Depreciation, etc.	0 18 5
V.S. and Medicines	0 10 9
Sundries	0 4 8
	£6 16 10
Net cost per horse per annum	£36 7 7
Net Cost per horse per week	0 14 0
Cost per Horse Hour—in pence	5·11
Average No. of Hours of Work per Horse per week	32¾

Wyllie* in the preceding illustrations shows the principles adopted in arriving at the Cost of Horse Labour in the years 1926–31.

The figures are now out of date owing to

* James Wyllie "The Cost of Horse Labour—1926/27 to 1930/31."

changed conditions and this Table is given here merely to indicate the detail that has to be collected in order to arrive at the result.

It will be seen that the farm has to be costed before the cost of the home-grown food can be ascertained. The same applies to the grazing. The total cost of the farm labour has to be divided by the number of hours worked before it is possible to charge the horses with the cost of labour expended on this particular work.

FARM COSTS PER ACRE OF GROWING SUGAR BEET

	£	s.	d.
Manual Labour	£4	12	0
Horse and Tractor Labour	1	15	2
	£6	7	2
Farmyard Manure	2	1	3
Artificials and Lime	3	8	8
Seed	0	17	6
Rent and Rates	1	9	8
Overhead Charges	0	16	8
	15	0	11
Carriage to Road	1	1	5
	16	2	4
Credit for residues	2	5	10
Net Farm Cost	£13	16	6

Acres surveyed	772
Yield per acre, tons	9·89

Bridges shows in detail that in 772 acres surveyed in the West Midlands, the net farm cost amounted to £13 16s. 6d. per acre, and the yield per acre was 9·89 tons.

DAIRY HERD ACCOUNT

Dr.		Cr.	
To Valuation:		By Bank:	
Cows and Bull		Cows sold	
,, Bank:		Calves sold	
Cows purchased		By Valuation:	
Heifers ,,		Cows and Bull	
Home Grown Foods		Manurial Residue of Foods:	
Hay		a. Farmyard Manure	
Straw		b. Grazing	
Grain and Meal		By Balance	£1,000
Swedes			
Mangolds			
Purchased Foods			
Linseed			
Cotton Cake			
Palm Kernel			
Beet Pulp			
Dried Grains			
Grazing			
,, Labour:			
Manual			
Horse			
,, Establishment Expenses			
,, Dairy Expenses			
,, Milking Machine Expenses			
	£3,000		£3,000

The amount of the Balance divided by the number of gallons produced gives the cost of production of 1 gallon of milk.

$$\frac{20{,}000 \text{ gal.}}{\pounds 1{,}000}$$

Farm, Labour Analysis for week ended ....

:—	FIELD A.					FIELD A.					HORSES.					FIELD B.					FIELD B.											
	Man Hours	Horse Hours	£	s.	d.	Man Hours	Horse Hours	£	s.	d.	Man Hours	Horse Hours	£	s.	d.	Man Hours	Horse Hours	£	s.	d.	Man Hours	Horse Hours	£	s.	d.	Total Man Hours	Total Cost Hour Work £	s.	d.	Total Cost £	s.	d.

* Field A, Horses, Field B, etc., correspond to Ledger Accounts. These accounts are debited with the Man Hours, and Horse Hours. At the end of the year the total amount paid for Wages [r]educed to a Flat Rate per hour. The cash value of the Horse Hours, and in the case of a Tractor—the Tractor Hours, are dealt with in the same way.

RECORDS NECESSARY FOR COST ACCOUNTING.

1. Labour.
2. Manures.
3. Feeding Stuffs.
4. Granary.
5. Implements.
6. Miscellaneous Stores.
7. Tractor Fuel.
8. Live Stock Register.
9. Manure and Food Residues.
10. Cleaning of Land Costs.
11. Establishment Charges.

________________FARM

TIME SHEET. *For Week ending* ____________ *193*

*Employee's Name*________________________

Sheet to be entered up every evening and the exact time in hours to be charged to each separate job.

Description of work and as far as possible amount done	Ordinary Time	Weekday Overtime	Sunday Overtime	Piece Work £ s. d.	Horses Used	No. of field or job where employed
1st day						
2nd day						
3rd day						
4th day						
5th day						
6th day						
7th day						
Total						

Summary of Wages and piece Work :— £ s. d.

..................Hours ordinary time @ ... ...

.... " weekday overtime @ ... ...

.... " Sunday overtime ... ...

Total Wages ... ...

Piece Work and Extras ... ...

Deductions :— £ s. d.

Cottage Rent ... ...

Employer's Initials Milk..................pints @.........

.... Potatoes @ ....

Worker's Initials Insurance (Employee's Contrib.)

.... Net amount due to Worker £

MANURE RECORD

Quantity in Stock on Jan., 1943			Name of Manure	Bought			Quantity in Stock on Jan., 1944			Applied to Land			ACCOUNTS														
													Field A			Field B			Field C			Field D			Field E		
T.	C.	Q.		T.	C.	Q.	T.	C.	Q.	T.	C.	Q.	T.	C.	Q.	T.	C.	Q.	T.	C.	Q.	T.	C.	Q.	T.	C.	Q

Statement of all Foods and Corn received, consumed, and in stock

Week ended..........................194

DATE			OATS			BARLEY			PALM KERNEL			COTTON CAKE			LINSEED CAKE			PULP			DRIED GRAINS			GROUND NUT		
			C.	Q.	LB.	C.	Q.	LB.	C.	Q.	LB.	C.	Q.	LB.	C.	Q.	LB.	C.	Q.	LB.	C.	Q.	LB.	C.	Q.	LB.
	Brought forward ...		20	0	0	11	0	0	15	0	0	30	0	0	17	2	0	80	0	0	25	0	0	10	0	0
	Purchased ...																									
	4 tons Pulp ...																	80	0	0						
	2 tons Cotton Cake											40	0	0												
	Totals in		20	0	0	11	0	0	15	0	0	70	0	0	17	2	0	160	0	0	25	0	0	10	0	0
	How used ...	No.				3	0	0	4	0	0							3	0	0				3	0	0
	Cows ...								1	0	0															
	Heifers ...														0	2	0									
	Calves ...		0	2	0							0	1	0												
	Bull ...																									
	Ewes ...																									
	Tegs ...																									
	Horses ...		5	0	0																					
	Pigs ...					0	2	0																		
	Sows ...																									
	Stores ...																									
	Totals out ...		5	2	0	3	2	0	5	0	0	0	1	0	0	2	0	3	0	0	0	0	0	3	0	0
	Carried forward ...		14	2	0	7	2	0	10	0	0	69	3	0	17	0	0	157	0	0	25	0	0	7	0	0

GRANARY BOOK

THRESHING				HOW DISPOSED OF				
Date	Stack	Corn	Tail Corn	Date	Sold	Fed	Seed	Remarks
		C. Q. Lb.	C. Q. Lb.		C. Q. Lb.	C. Q. Lb.		
Dec. 13	Field ...	50 0 0		Dec. 15	40 0 0 Walls & Co.	Feeding Stuffs 10 cwt.		

IMPLEMENT BOOK

Implement	Cost or Value	Life	Annual Depreciation	Limit of Depreciation	1942	1943	1944	1945
	£ s. d.		£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
Plough	6 0 0	10 year	0 11 0	0 10 0	6 0 0	5 9 0	4 18 0	4 7 0
Cart	20 0 0	10 ,,	2 0 0	2 0 0	20 0 0	18 0 0	16 0 0	14 0 0

MATERIALS USED AND WORK DONE BY TRACTOR

	First Day	Second Day	Third Day	Fourth Day	Fifth Day	Sixth Day	Seventh Day	Weekly Summary
Quantity of Paraffin Tank	5 gall.	4 gall.	6 gall.	4 gall.	1 gall.	Nil		
Added	10 gall.	11 gall.	12 gall.	5 gall.	Nil	13 gall.		
Total ...	15 gall.	15 gall.	18 gall.	9 gall.	1 gall.	13 gall.		
At end of day ...	5 gall.	6 gall.	4 gall.	2 gall.	Nil	4 gall.		
Quantity of Paraffin used	10 gall.	9 gall.	14 gall.	7 gall.	1 gall.	9 gall.		
Petrol used	1 pt.	1 pt.	1 pt.	1 pt.	1 pt.	1 pt.		Paraffin 50 gall.
Lubricating oil used ...	4 pt.	4 pt.	6 pt.	4 pt.	1 pt.	4 pt.		Petrol 6 pt. Oil 23 pt.
Work done	Ploughing	Ploughing	Ploughing	Ploughing	Ploughing	Ploughing		Field 10 Ac 10
Field	Field 10	Field 10	Field 10	Field 1	Field 1	Field 1		Field 1 Ac. 5¾
Acreage	3 acres	3 acres	4 acres	2 acres	¾ acres	3 acres		

LIVE STOCK RECORD

Stock	No. at Start of Week	No. Born	No. Bought	No. Transferred in	Total	No. Died	No. Sold	Total Died and Sold	No. Transferred out	No. at end of Week	Remarks

Labour Records.

The Labour Record especially on the mixed farm is the most difficult and irksome record to keep. Each man can be provided with his Labour Sheet.

In the foregoing pages have been shewn several records that are used in the collection of data when costing a farm. With such records the Double Entry system of accounting is used and the different accounts are debited with all the charges that are directly made in the production of the different commodities.

COSTINGS LEDGER.

When the accounts in the Costing Ledger are completed they have a slightly different appearance from those seen in the Financial Accounts Ledger. For example, the Balance in the Rent Account is not taken to the Profit and Loss Account. It is allocated to the various fields on the Holding.

RENT ACCOUNT

Dr.		Cr.	
To Bank	£150	By Field A	£50
„ Bank	150	„ „ B	60
		„ „ C	30
		„ „ D	40
		„ „ E	60
		„ „ F	27
		„ „ G	33
	£300		£300

The total of the Wages Account is distributed throughout the whole of the work done on the farm.

WAGES ACCOUNT

Dr.		Cr.	
To Bank	£500	By Sundry A/cs.	£500

The Sundry Accounts will include those of the Dairy Herd, Sheep, Horses, Oats, Barley, Wheat, Roots and all other sections of the Farm. These different sections will be debited so as to complete the double entry of £500 seen on the Credit side of the Wages Account.

The Feeding Stuffs Account will show that the Feeding Stuffs have been transferred to the various Live Stock sections.

FEEDING STUFFS ACCOUNT

Dr.		Cr.	
To Valuation	£10	By Valuation	£20
„ Bank	190	„ Sundry A/cs.	180
	£200		£200

As already stated the Farmer who is interested in Costing is advised to get into touch with one of the Advisory Centres, so that he can have guidance from the Advisory Economist for his own Area.

Valuations.

Valuations in Cost Accounts are necessary at the beginning and at the end of the year for the opening and closing of the Accounts, as in the case of financial Accounts.

The method usually used by Cost Accountants in the case of breeding stock is the Standard Valuation. In the case of other Stock the valuation is taken at cost.

The Standard Valuation is used to eliminate factors that would affect the cost of production of the commodity. Feeding Stuffs and Labour which form a large part of the cost of milk production are fairly constant throughout the country. They are direct charges against the production, and are settled by payment. If the valuation of the cows were allowed to fluctuate it might introduce a most disturbing factor with no bearing on the production of the commodity. If a farmer purchases an engine to drive the milking machine, he does not raise its value every time the price of milk rises, nor does he reduce its value when milk prices fall. It is part of the production machinery, and the cow can be looked upon in the same light. If the Dairy Herd is valued at the beginning of the year at £1,000 it will be valued again at £1,000 at the end of the year, provided the animals and the number have not changed.

Dairy Heifers coming into the herd may cost say £20 each, which means that they will be valued at £20 throughout the period of their presence in the herd. If a cow costs £26 to take a reasonable 1939 figure, and the only sane one to use at the moment of writing, she will remain at £26 as long as she is in the Dairy Herd. If an animal dies, the milk cost is increased, and if an animal is sold, at a figure above that shown in the valuation, the cost of the milk is decreased.

Financial Accounts and Farm Management.

The impression that financial accounts are

written entirely for taxation purposes is altogether wrong.

The management and organization of business are based, to a large extent, on the financial accounts.

The capital invested in a business in one year is compared with that of other years and with other businesses, and this applies to the business of farming. The farmer, like any other business man, can make comparisons, and if he farms more than one holding, he has a bigger field in which to operate.

The capital can be divided into that which is invested in Live Stock and Dead Stock. The Dead Stock can again be divided into Implements, Machinery, Crops, Produce, seeds, and so on.

Comparisons can be made between the Receipts for Cattle, Horses, Sheep, Pigs and Poultry during the year. The Cattle Receipts of one year can be compared with the Receipts of other years, and with the Receipts of the other holdings. Similar comparisons can be made with Horses, Sheep and other Live Stock sections. A record of Receipts from Oats, Barley, Wheat, Potatoes, Sugar Beet and other crops make it possible to compare one crop with another. It also provides data for comparison over different periods, and with holdings in various districts farmed by the same farmer.

The expenses or charges on the cattle and other livestock sections can be analyzed and investigated. Expenses on foods can be compared with other years and with sales of live stock and produce. Investigations can be made as to the expenditure on seeds and manures and on the returns from crops.

The expenditure on wages offers a large scope for study. This expenditure must be examined very closely with returns from the various sections of the holding. Skilled labour can be measured with casual labour. Both classes of labour can be compared in semi-industrial areas with areas that might be described as agricultural districts. It can also be examined in terms of Capital invested in the holding. The family labour presents a problem. In normal times if this type of labour were charged against profits at the rate ruling in the district for skilled and casual labour, the final results might not be very satisfactory. The position at the moment is that unless family labour is charged and paid for, the farmer cannot derive the benefit enjoyed by the farmer who employs paid labour.

There can be too much capital invested in a business. It is possible to see over-capitalization in a farm business. A simple line of procedure (both in examining such a problem and of reducing the use of capital) can be adopted by use of the financial accounts. Again from the use of financial accounts a farmer is in a position to make the necessary observations in deciding whether the capital of the business should be increased or not.

In other industries, the gross profit percentage on the turnover is measured from the financial accounts. The percentage return on capital invested is dealt with in the same way. No satisfactory evidence indicates that in the business of farming any other procedure should be adopted.

Among the many advantages of keeping financial accounts at the present time is the possibility that they may be very important in the future. When value of the raw material of the farm is deducted from that of the output there is a balance, or fund, left from which the three human elements of the farming industry live. Twenty-five years or more ago we spoke of a rent for the farm workers, a rent for the landlord, and a rent for the farmer. This, of course, meant that the landlord received his rent, the farm workers received their wages, and the farmer received his share.

These constituted what the economists call Net Output. With this idea from the past in mind, it will be clear that financial accounts are very necessary, if only for guidance when the Utopians reorganize the new world. The accounts will then at least provide evidence from which all the interested parties may receive justice.

If financial accounts had been kept by all farmers throughout the past fifty years they would have provided a valuable fund of knowledge for the rising generation. The farmer's memory is probably the best in the world, but it is not as good as the written record. Such accounts would have provided data not only for the sons of the farmer but for farmers' representative bodies, and for governments throughout the world. The Farmers' Unions, Chambers of Agriculture, Ministries of Agriculture, and business men can do much more good work for the industry with financial accounts to aid them than they can by having guessing competitions.

Good farm accounts have been described as farm management in figures.

Supposing that it is decided to grow a field of oats measuring 20 acres. Over the past quarter or half century very little change if any has been made in the cultivations and practically all the changes are found in figures.

The field is ploughed once. Previously this was done by a man and a pair of horses; now the tractor assists. At one time one acre was ploughed by a man and a pair of horses in a day. Perhaps at the present time they take longer. In any case the only change is seen in the accounts.

The accounts show the cost of maintaining the horse, and that divided by the number of working days gives the cost of a day's horse work. The accounts in some cases show that the figure amounts to 4/–. The man's wage probably works out at 10/– or 11/– per day. It is reasonable to conclude that the cost of ploughing an acre is somewhere in the vicinity of 20/–. Old

accounts would have shown the figure at 8/6 per acre.

The accounts again record the particulars of the tractor maintenance, and the tractor driver's wages. These again can be reduced to a day's work, and a comparison made between the horse and the tractor.

From observations in the field, and from observations upon the accounts, a man with an open mind can make any changes that are necessary in settling ploughing problems, and the same principle applies to most of the other work on the farm.

The next operation is to harrow the field before sowing, for this is always done when the seed is to be sown by drill. The quantity of seed sown is fairly constant; it is about 3–4 bushels per acre. Any changes made are seen in the accounts. The cost of the seed (as shewn by the invoice) and the cost of transport are both account records. The field is harrowed once after sowing. A man and a pair of horses will harrow 14 or 15 acres per day, say at a cost of 8/– for the pair of horses and 10/– or 11/– for the man.

The manure mixture may be Supers, Kainit, and Sulphate of Ammonia, and the prices can be ascertained from the accounts. The quantities are probably 3, 2 and 1 (in hundredweights per acre), and one man and one horse, doing say 8 acres per day, will be required to apply the manure.

The amount invested in corn-drop implements is seen in the accounts. The depreciation at 10 per cent can be charged against the corn crops as a whole and a proper proportion charged to the 20 acres of Oats.

In harvesting we may find that two men can open the field in one day. The crop, a good standing one, might be cut by two men and six horses in one day of 9 or 10 hours. Six men might stook the field in one day. However, the time will always be shown in the records.

The field might be led in two days with 4 men and 4 horses. There would be 2 men forking in the field and 2 men on the stack. A boy and a horse would probably rake the field in one day.

The state of the crop, the weather and other conditions might upset the foregoing calculations, but the records and accounts will supply all the figures and enable the farmer to compute the cost, including all interruptions and changes.

Reference to the accounts will show how to deal with the hire of the threshing machine, the coal used, and other particulars relating to this Oat crop we have been considering.

The writer has interested himself in practical farm management and in farm economics in at least eight countries, and he is aware that a hundred and one factors present themselves and upset the plans of men.

One outstanding observation, and it is not confined to one country, is that there is a lack of knowledge, by the farming community as a whole, of the values of work and commodities produced on the farm. A percentage of farmers is exceedingly well versed in such matters, but it is not a very high percentage.

Business men who in other industries work on very narrow margins understand the values of their commodities to the fraction of a penny. It is not to be expected that farmers who work under very variable conditions can work on very fine calculations but the other very great extreme of uncertainty is sometimes difficult to understand.

"What does it cost you to grow that crop?" Often the answer is, "A fair amount," or "A lot," or "Too much."

The intelligent use of Farm Accounts will enable the farmer to investigate costs and to make criticisms, based on fact, in every section of his Farm Management.

The reasons given for farmers not keeping accounts are that they live an open-air life, that they have inherited certain habits, that traditions have been handed down that farming is an art and not a business, and that farming is a science.

Consciously or unconsciously farmers have acknowledged legally, that farming is a business; and since sound business is based on good accounts, it is surely in the farmer's interest to spend a little time on this part of farm-management.

When looking over the pre-war accounts of a farm it might be seen that the cultivations and other expenses of ten acres of potatoes amounted to £190. The 8 tons of ware potatoes per acre, together with the seed and chats might be expected to shew practically a straight balance (with no profit or loss). If, during the War, the production expenditure were as much as doubled there is every reason to believe that the crop would show a profit of £300. It is impossible to farm long at the bottom figure, and the high figure cannot be expected to continue indefinitely. The farmer in possession of management accounts can refer quickly to different periods and be in a position to adapt himself more quickly to changing conditions than the farmer who has to fall back on his memory or to someone else's memory before he can decide upon any definite change in policy.

Among many other points that may be included in the question of farm accounts and management are the Capital outlays of Landlords and Tenants and the actual returns on each. The stocking of farms, and the income and expenditure based on the different systems of farming, are so much matters of Farm Accounts and Management that since the efficiency of management is measured by the Profit and Loss Account, the two must be considered together when we are looking for a business measure of the most progressive efficiency.

Some of the older generation of farmers remember how farms were managed before the

1914–18 War, and recall the prices that were ruling for the products of the farm at that time. They also remember the costs and market prices that were current during the War. After the War many people unfortunately overlooked or forgot the usual conditions of peace-time farming.

Financial accounts and records would have assisted them in bringing their judgments back to normal more rapidly than was possible with nothing but the memory for guidance. History is more likely to repeat itself; and not only to assist the memories of older people, but for the guidance of the younger generations (some of whom know nothing of peace-time farming), the very natural precaution of keeping an eye on simple accounts will be well rewarded.

Many farm disasters would have been checked or averted if only financial and legal advisers had been in possession of accounts and records to guide them, but in those cases the necessary information was not at hand. The farmer knew that the situation was not what it ought to be, but he had not realized the real financial position of the farm until the change over to peace-time farming had gone too far for recovery.

Memories are short. There is, as there was, a great deal of fantastic farming being carried out by farmers and Agricultural Executive Committees. There will be, as there was, a very substantial sum lost in the venture. The work of food production has had to be done. The Government bodies will expend large sums of money as part of the war-time policy, but the individual is without unlimited resources.

The infantryman with imagination may look back from the front line and visualize the thousand people needed to keep him in the line. The Agricultural Executive Committees produce one blade where no blade grew before. One ton of Oats, if it cost £100, is more valuable in wartime than money. Both jobs are costly, fanatical, and necessary. With foresight it is, however, possible to deal with the aftermath and one method of securing a protection or insurance against trouble is to study the financial accounts and to look upon the farm management and the accounts as one.

Valuations.

Valuations have to be made at the beginning and at the end of the year so as to arrive at the true result of the farmer's business or trading over that period (known as the Financial Year).

At one time a valuation was made at the beginning and at the end of a lease. Many of the leases stretched over a very long period.

Numerous changes are taking place in farming and it is necessary as far as possible to keep pace with the times. The farm worker at one time received 30/– with board and lodging for six months' work. Within the writer's lifetime it rose to £4/10/–. Today the figure is more than £50.

Good cows could be bought a generation ago for £17. Good cows can be bought today for £70.

Although in the old days the valuation made at the beginning and at the end of the lease served its purpose and with other data presented the farmer with the result of fifty years' farming, the system must be described as being a little Victorian. The modern practice is to measure one's income annually, and apart from the personal interest in such matters, there are certain legal claims upon income which call for an annual valuation.

Valuation is one of the controversial subjects of farming. There are the valuation for Tenant Right, the valuation for the farmer's private information, the Costing valuation, the Taxation valuation, and the Sheep stock and acclimatization valuation.

Tenant Right Valuation.

Tenant Right Valuers usually base their computation on Acts of Parliament, Leases, Inventories and customs of the country in arriving at the figure upon which compensation should be paid.

They base their values upon principles that will secure justice between the outgoing and the incoming tenants.

The Agreement, if in order, takes priority over other evidence, and points of importance are so well defined in the Acts that we are gradually becoming less dependent upon the Customs of the country when making decisions on the rights of Tenants.

If a farm comes under the Agricultural Holdings Act 1923, the ground for a claim for compensation will arise under the first Schedule.

FIRST SCHEDULE.

PART I.

IMPROVEMENTS TO WHICH THE CONSENT OF THE LANDLORD IS REQUIRED.

1. Erection, alteration, or enlargement of building.
2. Formation of silos.
3. Laying down of permanent pasture.
4. Making and planting osier beds.
5. Making of water meadows or works of irrigation.
6. Making of gardens.
7. Making or improvement of roads, or bridges.
8. Making or improvement of watercourses, ponds, wells, or reservoirs, or of works for the application of water power or for supply of water for agricultural or domestic purposes.
9. Making or removal of permanent fences.
10. Planting of hops.
11. Planting of orchards or fruit bushes.
12. Protecting young fruit trees.

13. Reclaiming of waste land.
14. Warping or weiring of land.
15. Embankments and sluices against floods.
16. Erection of wirework in hop gardens.
17. Provision of permanent sheep-dipping accommodation.
18. In the case of arable land, the removal of bracken, gorse, tree roots, boulders or other like obstructions to cultivation.

(N.B.—This part is subject as to market gardens to the provisions of the Third Schedule.)

PART II.

IMPROVEMENT IN RESPECT OF WHICH NOTICE TO LANDLORD IS REQUIRED.

19. Drainage.

PART III.

IMPROVEMENTS IN RESPECT OF WHICH CONSENT OR NOTICE IS NOT REQUIRED

20. Chalking of land.
21. Clay-burning.
22. Claying of land or spreading blaes upon it.
23. Liming of land.
24. Marling of land.
25. Application to land of purchased artificial or other purchased manure.
26. Consumption on the holding by cattle, sheep or pigs, or by horses other than those regularly employed on the holding, of corn cake, or other feeding stuff not produced on the holding.
27. Consumption on the holding by cattle, sheep, or pigs, or by horses other than those regularly employed on the holding, of corn proved by satisfactory evidence to have been produced and consumed on the holding.
28. Laying down temporary pasture with clover, grass, lucerne, sainfoin, or other seeds, sown more than two years prior to the determination of the tenancy.
29. Repairs to buildings, being buildings necessary for the cultivation of working of the holding, other than repairs which the tenant is himself under an obligation to execute.

    Provided that the tenant, before beginning to execute any such repairs, shall give to the landlord notice in writing of his intention, together with particulars of such repairs, and shall not execute the repairs unless the landlord fails to execute them within a reasonable time after receiving such notice.

THIRD SCHEDULE.

IMPROVEMENTS SUBJECT TO SPECIAL PROVISIONS IN THE CASE OF MARKET GARDENS.

1. Planting of standard or other fruit trees permanently set out.
2. Planting of fruit bushes permanently set out.
3. Planting of strawberry plants.
4. Planting of asparagus, rhubarb, and other vegetable crops which continue productive for two or more years.
5. Erection or enlargement of buildings for the purpose of the trade or business of a market gardener.

Customs of the Country.

One or two examples of the Customs of the country are given to show the main points upon which valuations and the usual terms of agreement are based.

CUMBERLAND.

Entry—Candlemas generally; Lady Day occasionally.

Pre-Entry and Holdover—None usually. Occasionally the outgoer leaves the land at Candlemas, and the buildings at May-day; in such cases he must consume the whole of the hay, straw and roots and leave the manure free for the incomer.

Away-going Crop—Not usual, but if wheat is sown in the autumn, the seed, cultivation and one year's rent and rates are paid.

Incoming Valuation includes hay, straw, seeds sown in the last year, and bare fallow, if any, made in the last year.

Hay and Straw—The tenant must consume all hay and straw on the premises, except in the last year of the tenancy, when he is bound to keep up his regular stock of horses, cattle and sheep to the end of the term, and he is then entitled to sell off at market price any vestures remaining unconsumed. Where agreements exist it is often provided in Candlemas tenancies that the tenant must consume at least one-half of the last year's crop of hay and straw, and the remaining half shall be taken by the incomer at consuming price. In a Lady-Day tenancy the outgoer must consume at least two-thirds.

Manure belongs to the Landlord; labour of carting and spreading allowed in the last year.

Seeds and Cultivations—Young seeds, when they have not been depastured after November 11th, and have been kept uninjured, are paid for at the cost of seed and sowing. Bare fallows are allowed at the cost of labour and one year's rent and rates. If the land has been sown with wheat, the cost of the seed is added. Land is cultivated on a five-course system.

Customary Payments for Unexhausted Improvements—Compensation for feeding stuffs is now usually based on Voelcker and Hall's tables.

Repairs—Landlord repairs main walls, timbers and roofs; tenant does other repairs, including gates and fences.

NORTHUMBERLAND.

Entry—May 13th.

Pre-Entry—The incomer enters on February

2nd to plough for fallows, and at a later date to sow seeds in the spring corn.

Holdover—Occasionally of barn, cottage and two stalls in stable till May-day of following year for dealing with away-going crops.

Incoming Valuation includes seeds of previous year if uneaten, and unexhausted improvements, and usually the crops previous to harvest.

Away-going Crops—Usually taken by the incomer at a valuation before harvest, making allowance for reaping and marketing; but where this is not done the tenant has the right of holdover.

Hay and Straw—Formerly these had to be consumed on the premises, but it is not now compulsory, the out-going tenant making an allowance for manurial value of quantity removed.

Manure—Belongs to the landlord and passes free but it is usual to pay for carting and spreading.

Unexhausted Improvements—Generally allowed on the scale of the Newcastle Farmers' Club, which is, in principle, as follows:—Farms are divided into three classes, according to their management and the effects produced. Class I comprises lands where the effects produced have been very beneficial to the incomer. Classes II and III where the effects produced have been relatively less advantageous. On this basis under-drainage is allowed in Class I on thirty-five years' principle, Class II on twenty-five years', and Class III on fifteen years'. Boning on arable land is allowed on six, five and three years' principle; liming on arable land is paid for in ten, eight and six years; on pasture, in twelve, ten and eight years respectively. In purchased farmyard manure the exhaustion of each crop on arable land is one-fifth, one-fourth, and one-third respectively, and on pasture one-ninth, one-seventh and one-sixth; other manures in a similar manner according to their exhaustion. For compensation for the residual manurial value left by the consumption of artificial and other foods, the Club has adopted Voelcker and Hall's tables, with an additional percentage to meet the increased cost of the constituents. Compensation is restricted to the last two years of the tenancy.

Repairs—Landlord repairs roofs, main walls and timbers of buildings. Tenant does other repairs and keeps fences and gates in order.

YORKSHIRE.

Entry—Various dates of entry prevail, but the most usual time is April 6th.

Pre-Entry—Entry to plough fairly general in both north and east on February 2nd, and sometimes on November 1st.

Holdover—None as a rule, except away-going crop land.

Away-going Crop—One-third of the arable land is generally allowed, but sometimes one-fourth. The away-going crop is sown by the outgoer and taken by the landlord or comer, the crop being valued prior to the harvest and the purchase completed in January or February following. When the valuation is due to be paid the value of the crop is estimated from the average price of corn from harvest to date of settlement. Sometimes a deduction of the average rent and rates on the whole farm is made from the away-going crop; also the expenses of harvesting, threshing and delivering, but in other cases only rent and rates are deducted. As a rule the straw of the away-going crop is not estimated in the valuation. In a few cases the manurial value is allowed, but this is quite the exception.

Incoming Valuation at Lady-day includes farmyard manure, unconsumed hay, straw, roots, seeds and cultivations.

Hay—Consuming price, where the manure belongs to the landlord, but market price, where the manure belongs to the tenant.

Straw—Consuming price, except in a few cases, when it passes without payment.

Manure—Generally paid for at market price.

Seeds, Roots and Cultivations—Clovers and other seeds are paid for at the cost of seed and sowing; roots at a consuming price.

Unexhausted Improvements—Compensation for feeding stuffs is based on Voelcker and Hall's revised tables, with slight modifications. Chalking, claying and marling are allowed on a twenty years' principle. Ground lime, on four years' principle. Boning, on grass land, on six years' principle where grazed; three years when mown. Boning on arable land, on a four years' principle.

Repairs—The tenant has to keep and leave the premises in repair, but in some cases is supplied with materials by the landlord. The tenant does the carting.

LINCOLNSHIRE.

Entry—Lady-day (April 6th).

Pre-Entry—None by custom. Agreements frequently secure the right of pre-entry for sowing spring corn.

Holdover—None, except by agreement. Sometimes to May 13th for pasture and homestead by agreement, or if so, on entry.

Incoming Valuation includes hay, seeds, cultivations, and all seed sown and labour done, tenant's fixtures, unexhausted improvements, and sometimes the following crop of wheat.

Away-going Crop—Where it exists it is nearly always purchased by the incomer.

Hay—Valued at a consuming price.

Straw—Taken at the cost of stacking, unless eatage value paid on entry.

Manure—Is the property of the landlord; carting and spreading only is paid for, except that, occasionally on the north-western borders of the country, it is at market price.

Seeds, Roots and Cultivations—Young seeds

are paid for at the actual cost of seed and labour (if sown in course) provided they have not been stocked after October 11th. Roots taken at consuming value. Labour on dead fallows allowed on heavy soils, but no rent or rates, unless paid for on entry.

Customary Payments for Unexhausted Improvements—One-third cost of linseed, cotton, rape or soya cakes and malt-culm fed in last year is allowed; one-sixth if fed in the year previous. Corn, corn cake and malt and similar feeding stuffs are paid for at the rate of one-sixth the cost if fed in the last year, and one-twelfth if used in the year previous. Voelcker and Hall's revised tables are now sometimes applied when a claim is made under the Act and not under custom. Liming is allowed on a seven years' principle; chalking and claying twelve years'; boning two years after a green crop, or on a ten years' principle on pasture; artificial manures are allowed for one or two years as follows:—The whole cost of that used upon green crops grown in last year; two-thirds of the cost on pasture land in last year and one-third in preceding year. Basic slag on a three years' principle. Also one-third of cost of artificial used with last year's potato crop where land is clean, provided it does not exceed one-quarter of the holding, and the maximum allowance not to exceed £1 an acre on land not adapted for growing corn after potatoes.

Drainage is paid for on a ten years' principle where landlord finds the tiles, or fifteen years where tenant finds both labour and tiles.

Repairs—Where no agreement exists, or the agreement is silent as to repairs, custom requires the tenant to keep and leave all gates and fences in fair tenantable repair. At the expiration of the tenancy, the new tenant, with the authority of the landlord or his agent, usually claims dilapidations as a set-off to the tenant right.

STAFFORDSHIRE.

Entry—Lady-day generally; some Michaelmas entries.

Pre-Entry—Not common; occasionally the incomer is allowed entry to plough on February 1st, accommodation for men and horses being provided.

Holdover—Is now unusual.

Away-going Crop—Outgoer is entitled to two-thirds of crop of wheat after summer fallow, and one-half after clover ley, peas or beans, less whole cost of reaping, and cost of harvesting and marketing the share. The straw passes to the incomer unless paid for on entry.

Incoming Valuation includes hay, straw, roots, seeds, cultivations and tenant's fixtures.

Hay and Straw—Taken at a consuming price.

Manure—Belongs to the landlord, and is left without payment except for carting, unless paid for on entry.

Seeds, Roots, and Cultivations—Incomer pays for clover and grass seeds sown, and labour; roots are taken at consuming value; tillages are paid for on fallows and winter ploughings, but rent and rates are not allowed unless paid for on entry.

Customary Payments for Unexhausted Improvements—Payments for unexhausted improvements are made in accordance with a scale of compensation values drawn up by the Staffordshire Tenant Right Valuers' Association and based on Voelcker and Hall's revised tables. The values are varied according to the current prices of the manurial constituents. Their table of values on purchased manures has also been adopted with modifications. Raw bones are allowed on a three to five years' basis on pasture and two years' on arable. Dissolved bones up to two years' and superphosphate up to three years'. Basic slag up to three years' on pasture and two years' on arable. Quicklime is allowed on an eight years' basis on pasture and four years' on arable, with cost of hauling and spreading. Ground lime is on a three years' scale.

Repairs—In leases of seven years and upwards, landlord repairs main walls and roofs of buildings, and tenant does other repairs, for which landlord generally provides timber and other materials. In tenancies from year to year, or less than seven years, all repairs to buildings except internal work are done by landlord.

SHROPSHIRE.

Entry—Usually Lady-day.

Pre-Entry—After November 1st or earlier in some cases to plough stubbles; accommodation provided for horses and men. In part of South Shropshire there is no pre-entry as the outgoer does the work and is paid by valuation.

Holdover—Part of house and farm buildings and a boosey pasture until May 1st, for consuming produce.

Away-going Crop—The customary share of the outgoer in the wheat crop is two-thirds of the away-going crop if after summer fallowing, or one-half if after clover ley, beans or peas, not exceeding one-fourth of the area of the arable land. By custom the outgoer rolls and weeds, cuts and stooks the whole crop, and harvests, threshes and markets his share, but it is now usual for the outgoing occupier's share of the crop to be taken at a valuation just before the crop is ready for cutting, and an allowance of about 30s. per acre deducted from the outgoer's share for this work. The straw, and any wheat in excess of the fourth of the arable, pass to the incomer without payment.

Incoming Valuation includes unconsumed hay, straw and roots to a moderate amount, seeds and cultivations, labour to dung and tenant's fixtures.

Hay and Straw not used on the farm must be left at consuming price. When there is a boosey pasture this is for the express purpose of con-

suming hay, straw and roots except sufficient of the first two named for horses.

Manure—Left without payment, except for reasonable labour. On a few estates it belongs to the tenant, and is valued, consideration being given to manurial value of feeding stuffs which is already paid for under unexhausted manurial values.

Seeds, Roots and Cultivations—The seeds of the spring previous to quitting are paid for at cost of the seed. Roots in clamp are taken at consuming price. Compensation is also paid for ploughings and cultivations for the benefit of the incomer.

Customary Payments for Unexhausted Improvements—Compensation for feeding stuffs consumed is based on Voelcker and Hall's revised tables as adopted by the Shropshire Chamber of Agriculture. Compensation restricted to two years and not to exceed the average of the last three years. Drainage to be allowed on a ten years' basis where landlord finds pipes, and 20 years' where tenant finds pipes and labour. Undissolved bones three years on arable land and four years on grass land. Dissolved bones on three years' principle. Basic slag on grass land on seven years' principle, on arable land three years'. Superphosphate on grass or arable land three years', lime five to seven years', ground lime three years'. Cost of hauling and spreading lime is also allowed.

Repairs—As a rule the tenant is liable for repairs, landlord finding materials, but in practice the main structures, roofs, and walls fall to the lot of the landlord.

WARWICKSHIRE.

Entry—Both Lady-day and Michaelmas tenancies.

Pre-Entry—Not under custom, but some under estate agreements.

Holdover—None, but some by estate agreement.

Incoming Valuation includes hay, straw, seeds, roots, cultivations, fixtures, and unexhausted manurial values.

Away-going Crops—Only where it is provided by estate agreement or valuation on entry is an outgoer entitled to share of crop at harvest, except in a district around Birmingham, where the custom is recognized. The general custom is seed and labour on entry.

Hay and Straw—The whole is not valued at consuming price in case of Lady-day entry. A fair proportion should be consumed by stock during the last winter. In case of a Michaelmas take, the whole would be at consuming price.

Manure—Labour only is paid for under custom.

Seeds, Roots and Cultivations—Seeds are paid for at the cost of seed and sowing, roots unconsumed at a consuming price. All cultivations, artificials applied and seed from which outgoer derives no benefit are generally allowed. In South Warwickshire roots are valued at tons per acre, with an allowance for artificial manures applied up to £2 per acre.

Unexhausted Improvements—Allowances for feeding stuffs are based on manurial values. Liming and boning on a five years' scale for arable or grass mown, or ten years' for pasture. No allowance after three white straws. Marling on a seven years' principle. Basic slag allowed on a three years' scale on grass pastured, or one-half is paid after grass mown or after peas, beans, seeds or vetches mown.

Repairs—The landlord is usually under an obligation to do all structural repairs, and the tenant to do all other repairs and keep all fences and gates in order. The landlord supplies the materials necessary for repairs on application from the tenant. No allowance is made for laying hedges. On the other hand, if a tenant does not do a fair proportion of hedge-cutting, etc., each year of his tenancy, he is dilapidated for neglecting to do so at the termination of his tenancy.

GLAMORGANSHIRE.

Tenant right has a secure footing in South Wales and the County of Glamorgan ranks as a pioneer in the matter.

Entry—Michaelmas in the west, Candlemas in the east, and Lady-day in the centre.

Pre-Entry and Holdover—No pre-entry under custom. Holdover of house buildings and boosey pasture till May 1st in Candlemas and Lady-day tenancies. Gardens are given up at Lady-day. No holdover of cottages. With Michaelmas tenancies there is no holdover but sometimes the outgoer is allowed the use of the rickyard and barn until Novermber 1st.

Incoming Valuation in the east seldom includes hay and straw; in the west it is also the exception rather than the rule, and then at market prices less the manurial value which gives a consuming value; cultivations, seeds, and (in the east) hedges and unexhausted improvements.

Hay and Straw—Value after deductions according to "South Wales" scale of manurial values.

Manure—In the west of the county only manure in the yards and heaps is paid for. In the east and centre the outgoer is paid about 2s. 6d. per cubic yard, according to quality, with extra for filling, carting and spreading.

Seeds, Roots and Cultivations—When two-thirds of a fair crop of swedes and turnips are close-folded on the field with sheep, then the full costs of cultivations and manures are allowed with an extra allowance, if cake is also consumed on the ground. If by "long range" instead of close-folding, up to two-thirds of the cost is allowed. After mangolds, potatoes or legumes, half tillages and half values of manures are allowed and a similar allowance is made when

all the swedes and turnips are removed from the ground. Half values are also allowed after a corn crop has been taken in the year succeeding close-folded roots. Rent and rates are paid on summer fallow for twelve months, with cost of cultivations, but not exceeding four ploughings on stubbles, from the time of the ploughing in autumn. One-half year's rent and rates are allowed for a bastard fallow; and half cost of cultivations, but no rent and rates, if a crop is taken after a summer fallow. Three months' rent and rates with cost of seed, sowing, harrowing and rolling on young seeds not grazed after the corn is cut are paid for in the east and centre of the county, but if the seeds be grazed no rent and rates are paid by incomer. In the west seeds are paid for at face value. Temporary pasture, lucerne and sainfoin of more than two years' growth are usually according to face value.

Customary Payments for Unexhausted Improvements—Kiln-lime allowed on four years' principle on arable land, and seven years' on pasture. Gas-lime on three years' principle. Dry-stone walling and draining each on a fourteen years' basis. Hedging, ditching and banking (in the east) are paid for on a three years' principle. In the east and centre, farm and artificial manures applied to arable lands are paid for on a two summers' principle; and if applied to pasture, a three years' principle is recognized. In the west, whether on grass or arable, half the value plus labour is allowed for farmyard manure applied to the land the last year of tenancy, when one crop has been taken; and one quarter after two crops have been taken from it. Artificial manure is paid for at half cost when one crop has been taken. There has been for several years now a "South Wales" scale for unexhausted manurial values of feeding stuffs and manures adopted by the South Wales and Monmouth Agricultural Valuers' Association, which is generally used, the unexhausted value being taken on two summers' principle.

Repairs—Landlord generally does repairs, but sometimes the tenant is responsible for internal repairs and often for labour and hauling.

BEDFORDSHIRE.

Entry—Michaelmas.

Pre-Entry—Not very general, but in some cases incomer allowed to enter on fallows, and to sow seeds in corn at Lady-day, and he has the use of the stubbles for his horses.

Holdover—If hay and straw not taken by valuation, right to yards to Lady-day or May 1st, also barns and stackyards for marketing corn.

Incoming Valuation includes hay, straw, seeds, cultivations and labour to dung.

Hay and Straw—At a consuming price, but more particularly in the south it has become customary for the first cut seed hay and the wheat straw of the last year's growth to be taken at market price.

Manure—At cost of labour and cartage only.

Seeds and Cultivations—Cost of seed and sowing young seeds, provided they have not been fed; roots at cost of seed, artificials and cultivations, and, in some cases, the crop at consuming price; labour to bare fallow. No rent or rates, except in a very few cases, and these are becoming abolished as opportunities arise.

Customary Payments for Unexhausted Improvements—For feeding stuffs, Voelcker and Hall's tables are taken as a basis subject to modification. Chalking allowed on an eight years' principle. Drainage on a ten years' scale. One-half of boning allowed after a corn crop, and it is paid for on a three or four years' scale on pasture land.

Repairs—Tenant repairs buildings, gates and fences on being found materials by the landlord. Tenant is liable for labour and cartage.

NORFOLK.

Entry—October 11th.

Pre-entry—Unusual.

Holdover—Outgoer allowed one of the barns and room in stackyard for stacking, threshing and dressing corn up to May 1st, but earlier if work done.

Incoming Valuation—Hay, roots, manure, seeds and fixtures.

Hay—Taken at consuming price.

Straw—Incomer threshes, dresses and delivers corn, for which he has the straw, chaff and calder gratis. If any threshing is done before Michaelmas, outgoer must protect the straw and an allowance is made. Other special customs prevail on certain estates.

Manure—At a consuming value per load of 40 cubic feet.

Seeds, Roots and Cultivations—Seeds are taken at cost of seed and sowing. Roots are valued at consuming price.

Unexhausted Improvements—For feeding stuffs, Voelcker and Hall's revised scale has been adopted as the basis of valuation by the Norfolk Association of Agricultural Valuers. Boning is allowed for, on the basis of four years if applied to arable land, and on pastures eight years. Chalking, claying and marling (at full the first four years), 12 years. Pipe draining (landlord finding pipes), 12 years. If all found by tenant, 20 years.

Repairs—The landlord keeps main structures in repair. The tenant keeps the interior of house in repair, and, in some instances, pays for the labour of general repairs; he also keeps in repair gates, posts and rails, landlord finding materials.

The subject of Ordinary Valuation is pursued in this short section and a section is devoted to the use of parts of Voelcker & Hall's tables for the computation of compensation values.

Ordinary Valuation.

Although, before 1939, they were taxed under Schedule B, a certain number of farmers were in the habit of making an annual valuation of their farms for their own private information.

Date of Valuation.

As to the best date for making the valuation, any day in the year will do. It has been contended that the task is simplified if a day is selected when the stock is at its lowest. The Spring period is usually the first selection, for then the corn and straw are already sold or consumed and the stackyard is bare; the potatoes have been sold and the roots are almost finished. There are usually growing crops at this season of the year but many valuers prefer to cope with these than to make estimations of hay, straw, and grain contained in bulky stacks. Since farmers enter farms at certain terms of the year, and as valuations are often made on behalf of the outgoing and incoming tenants, and as the change marks the beginning of the new financial year, one of the terms on which the farmer enters the holding is frequently selected as the date of valuation.

The dates are Michaelmas (29th September), and Lady-day (25th March) in England, and Martinmas (28th November), and Whitsunday, in Scotland. For the reasons already mentioned in simplifying the valuation, Lady-day is preferred to Michaelmas, and Whitsunday is preferable to Martinmas. In thinking entirely in terms of Income Tax, the 1st to the 5th April would be very suitable for making the opening valuation, but the above-mentioned dates fulfil all the requirements.

Valuation Procedure.

On the appointed day it is necessary to go round the farm and make notes of every asset on the holding. The record includes all the livestock, and all the dead stock. The latter comprise purchased manures, feeding stuffs, consumable stores, home-grown food, implements, machinery, tools and all other equipment. The field operations for growing crops, and all the other cultivations ought to be included in the inventory.

Valuation Price.

The price at which the items have to be valued ought to be well considered. When valuing the livestock the market price, less one-tenth or one-twentieth, is often taken. Although the method is quite suitable when dealing with most of the livestock, there is always the difficulty of convincing some of the critics that the procedure is sound when valuing breeding flocks and cattle herds. Discussions on the subject have gone on for many years and only time will show whether the matter has been settled or not.

It has been suggested that livestock should be treated as stock-in-trade. This method has been thought to favour sections of the community when markets are falling. Taking the long view it has been considered that such a method would be unsatisfactory in times of rising markets.

A few farmers have always used a fixed price for dairy herds, and for breeding animals. If the cows were valued at £17 each at the beginning of a year, they were left in the valuation at £17 at the end of the year. The farmer paid no attention to market fluctuation. At the end of the 1914–18 War, market movements were very erratic and it was at that time and shortly afterwards that the subject of valuations was widely debated.

Store cattle, sheep and pigs are usually valued at slightly under market value, and this is looked upon as being quite sound. Although some valuers value all the livestock on the basis of market price, it is often considered that such a method does not exhibit the true position.

Implements.

A list of the implements is made, and 10 per cent is written off each year.

The crops are usually valued at a price slightly below market value. If they are in the stackyard the stacks are measured. If they are growing, the seeds, manures, and cultivations are included in the final figure.

The valuation when completed is presented in a summarized form showing the livestock section (with cattle, horses, sheep, pigs and poultry), the implements, the produce (including the oats, barley, wheat, and root crops), the tillages, the farmyard manure and the unexhausted improvements.

The Costing Valuation.

This type of valuation has already been considered, and the basis on which it is made is taken from the actual costs as found in the accounts.

Taxation Valuation.

The valuation of ordinary livestock is based on the Income Tax procedure of using the cost or market-value figure, whichever is the lower. In the event of the farmer being unable to procure the figure of cost, he can take the market figure less 15 per cent. If at the beginning of the year, the market value of the livestock is £100, he may record them in the opening valuation at £85. Should the market value of the same animals at the end of the year amount to £130, they are entered in the closing valuation at £110 10s. Store animals purchased at or about the date of valuation are entered at the cost price. Where a farmer has some other method of arriving at the

THE CENTRAL ASSOCIATION OF AGRICULTURAL VALUERS
(29 AFFILIATED ASSOCIATIONS)

FROM VOELCKER & HALL'S TABLE

(*As revised by Mr. Eric Voelcker, July*, 1939, *but see Note* 5)

Table shewing Compensation Value of Feeding Stuffs
(*Revised from Lawes & Gilbert's Tables*, 1897, *and Voelcker & Hall's*, 1902 *and* 1914)

No.	Foods	Compensation value for each ton of food consumed. (1) Before a crop has been removed (to nearest 6d.)	(2) After a crop has been removed
		s. d.	s. d.
1	Decorticated cotton cake	43 6	21 9
2	Undecorticated cotton cake (Egyptian)	25 6	12 9
3	Undecorticated cotton cake (Bombay)	24 0	12 0
4	Linseed cake	29 6	14 9
5	Linseed	23 6	11 9
6	Soya-bean cake	39 6	19 9
7	Palm-nut cake	15 6	7 9
8	Coco-nut cake	24 0	12 0
9	Earth-nut cake	42 6	21 3
10	Rape cake	31 6	15 9
11	Compound Cakes, Meals, etc.:—		
	(*a*) exceeding 15% but not exceeding 20% Albuminoids	21 0	10 6
	(*b*) „ 20% „ 25% „	24 0	12 0
	(*c*) „ 25% „ 30% „	27 6	13 9
	(*d*) „ 30% ... „	32 6	16 3
12	Beans	24 0	12 0
13	Peas	20 6	10 3
14	Wheat	11 6	5 9
15	Barley	10 6	5 3
16	Oats	11 6	5 9
17	Maize	10 0	5 0
18	Rice meal	11 0	5 6
19	Locust beans	9 6	4 9
20	Malt	11 6	5 9
21	Malt culms	27 6	13 9
22	Bran and other Offals of Wheat	23 0	11 6
23	Brewers' grains (dried)	19 0	9 6
24	Brewers' grains (wet)	4 6	2 3
25	Clover hay	16 0	8 0
26	Meadow hay	12 0	6 0
27	Dried Grass and Meal	17 6	8 9
28	Wheat straw	4 6	2 3
29	Barley straw	4 6	2 3
30	Oat straw	5 6	2 9
31	Mangolds	2 0	1 0
32	Swedes	2 0	1 0
33	Turnips	1 6	0 9
34	Sugar Beet Pulp (dry)	7 6	3 9
35	„ „ (wet	1 6	0 9
36	Potatoes	3 6	1 9

Note 1.—A deduction up to 25% should be made from a claim for Unexhausted Manurial Values of Feeding Stuffs consumed by Dairy Cattle, or a deduction computed upon the basis of the gallonage of milk sold off the farm—4/- per ton being the value in the last year of the tenancy and 2/- per ton as the value in the last year but one of the tenancy (220 gallons of milk is equivalent to one ton).

Note 2.—In practically all claims for Unexhausted Manurial Values of Feeding Stuffs consumed, loss occurs from wastage in some degree or other in consequence of the dung or urine not being properly conserved and a deduction should be made in such cases. With modern Cow Houses, Danish Piggeries and all such buildings in which Feeding Stuffs are consumed and particularly where water is used for washing down, if the whole of the urine is lost, the deduction can be as much as 50% of the amount of the claim in connection therewith. The situation, therefore, of the homestead, its drainage and other circumstances on the farm must largely govern the deduction to be made for wastage.

Note 3.—Where straw has been sold off, which would have been used for bedding, an additional deduction of 7/- per ton as representing the mechanical value should be made if sold or removed from the holding in the last year of tenancy and 3/6 per ton if sold and removed from the holding in the last year but one of the tenancy.

Note 4.—These Tables are periodically revised by, and at the expense of the Central Association of Agricultural Valuers. The present revision was made in July, 1939, and will serve for forthcoming Valuations. At the same time it will be remembered that the tables are only intended to serve as a working basis, and each case must be separately considered on its merits. Copies can be obtained from the Secretary of the Central Association, at the Farmers' Club, 2 Whitehall Court, S.W.1, price to non-members, 2/6, post free.

Note 5.—The money values in the table are subject to an increase of 25% (1943).

TABLE OF COMPENSATION FOR FERTILIZERS APPLIED

(1939 *revision of Messrs. Voelcker and Hall's Final Report on Manurial Values.*)

From such data as are available the following Scale of Compensation may be taken as some guide:—

	ON ARABLE LAND			ON GRASS LAND.				
	After 1st crop	After 2nd	After 3rd	After 1st year	After 2nd	After 3rd	After 4th	After 5th
Superphosphate	$\frac{2}{3}$ of cost	$\frac{1}{3}$	$\frac{1}{6}$	$\frac{2}{3}$ of cost	$\frac{1}{3}$	$\frac{1}{6}$	—	—
Basic Slag, Ground Phosphate, etc.	$\frac{2}{3}$	$\frac{1}{3}$	$\frac{1}{4}$	$\frac{5}{6}$	$\frac{2}{3}$	$\frac{1}{2}$	$\frac{1}{3}$	$\frac{1}{6}$
Bones (raw and steamed)	$\frac{2}{3}$	$\frac{1}{3}$	$\frac{1}{8}$	$\frac{2}{3}$	$\frac{1}{2}$	$\frac{1}{3}$	$\frac{1}{6}$	—
Dissolved Bones	$\frac{1}{2}$	$\frac{1}{4}$	$\frac{1}{12}$	$\frac{1}{2}$	$\frac{1}{4}$	$\frac{1}{12}$	—	—
Bone Manures	$\frac{2}{5}$	$\frac{1}{5}$	—	$\frac{2}{5}$	$\frac{1}{5}$	—	—	—
Compound Manures not containing Bone	$\frac{1}{3}$	$\frac{1}{6}$	—	$\frac{1}{3}$	$\frac{1}{6}$	—	—	—
Peruvian Guano	$\frac{1}{3}$	$\frac{1}{6}$	—	$\frac{1}{3}$	$\frac{1}{6}$	—	—	—
Fish Guano	$\frac{1}{3}$	$\frac{1}{6}$	—	$\frac{1}{3}$	$\frac{1}{6}$	—	—	—
Meat Meal	$\frac{1}{3}$	$\frac{1}{6}$	—	$\frac{1}{3}$	$\frac{1}{6}$	—	—	—
Shoddy and Wool Waste, Fur Waste, Hair, Hoofs and Horns, Greaves, etc.	$\frac{1}{2}$	$\frac{1}{4}$	$\frac{1}{8}$	$\frac{1}{2}$	$\frac{1}{4}$	$\frac{1}{8}$	—	—
Manure Cakes	$\frac{1}{5}$	$\frac{1}{10}$	—	$\frac{1}{5}$	$\frac{1}{10}$	—	—	—
Dried Blood, Sulphate of Ammonia, Nitrate of Soda, Nitrate of Lime, Cyanamide.	Nothing.			Nothing.				
Kainit and Potash Salts	$\frac{1}{2}$	$\frac{1}{4}$	—	$\frac{1}{2}$	$\frac{1}{4}$	—	—	—
Lime	On arable and on grass-land alike.							

(a) If used in quantities less than 1 ton per acre of lime.	After 1st crop $\frac{1}{2}$ (of cost) After 2nd crop $\frac{1}{4}$ (of cost)
(b) If used in quantities of 1 ton or more per acre of lime.	The cost of 4 cwt. of lime (CaO) to be deducted per acre each year after application until the amount originally applied be exhausted, provided that the period over which compensation shall extend does not exceed ten years.

The Valuer must exercise his discretion as to the suitability of these manures when used upon grass land.

These Tables, we would wish to explain, are based on the assumption that the manure in question is one suitable for the land. We recognize that the Tables can only be interpreted with considerable latitude, depending upon such varying factors as the nature of the soil, the course of cropping pursued, the climatic conditions, etc. Further, we consider that, when it is clear from the invoice, or when expert opinion has been brought to show that an excessive price has been charged for a manure purchased by an outgoing tenant, or when the cost has materially altered, the Valuer is justified in exercising his discretion as to an alteration he may make in the original price charged, and on which the compensation to be paid shall be based.

The Tables are intended, therefore, for general guidance, to be modified as circumstances demand.

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cost of the animals bred on the farm, provided it meets with the approval of the Inspector of Taxes, it is not necessary to make a change.

Regular Breeding Stock.

Where a dairy herd is kept for the production of milk, or a ewe flock for the production of lambs and wool, a change is made in the method of valuation. These animals are treated as fixed stock, and must not be confused with trading stock.

The cost of the herd or flock is entered in the valuation and treated as a Capital charge. Should the herd or flock be dispersed, the profit or loss made in the dispersal will not be taken into account for Income Tax purposes, but will be treated as a Capital profit or loss.

The Inland Revenue Department, in collaboration with the Ministry of Agriculture and the Department of Agriculture for Scotland, state in their booklet, " that if a substantial proportion of the herd or flock is sold on a definite permanent reduction, any profit or loss resulting from the transaction will be treated as a capital profit or loss and will be ignored for Income Tax purposes."

When a farmer replaces an animal he is allowed to charge the cost of the new animal as an expense, and he must show the price made by the old animal as a receipt. Anything in the nature of an improvement is not allowed as a charge in the cost of replacement.

Valuation of Tillages.

Special concessions are given where the value of tillages, unexhausted manures, and growing crops do not exceed £700. A certificate is usually accepted where there is no marked difference between the value at the beginning and the end of the year. The farmer who is in the habit of making a detailed valuation of the tillages, etc., on the basis of the tenancy agreement is encouraged to continue.

A Press Notice has stated that it has been agreed by the Inland Revenue Department that, subject to the concurrence of the District Commissioners of Taxes:—

(*a*) where the normal value of tillages, unexhausted manures and growing crops does not exceed £700, and a detailed valuation is not available, a certificate that the value at the beginning of the year did not differ materially from that at the end of the year will usually be accepted, and

(*b*) even where the normal value exceeds £700 a valuation will not be pressed for in every case and a similar certificate may be accepted after any enquiry necessary to establish its reasonable accuracy.

The object of this arrangement is to assist farmers by enabling a detailed valuation to be dispensed with in such cases.

There is, however, nothing in the arrangement (which is in terms limited to cases where detailed valuations are not available) to preclude a farmer, who so desires, from bringing into his accounts a full detailed valuation of tenant right or waygoing rights and liabilities at the beginning and end of the year; any farmer who makes a detailed valuation is at liberty to put in that valuation and should in fact do so. The valuation should be made on precisely the same basis as if valuing an outgoing tenant; in other words, the valuation would, in the case of a tenant, be based upon the actual tenancy agreement and, in the case of an owner-occupier, on the custom of the country which would, in the absence of a written agreement, be applicable if a tenancy existed.

In his last section our author deals with the subjects of Income Tax, Land Tax and Tithe with such illustrations as are necessary for a clear understanding of these matters.

INCOME TAX.

THE year 1798 saw the invention and imposition of Income Tax. It was discontinued some 18 years later, only to be revived by the Government, in search of Revenue, in 1842. Although since then the Tax has become one of the chief sources of National Revenue, it was not of much concern to farmers until 1940. Parliament imposes this Tax each year through the Finance Act, which is better known as the Budget.

The Income Tax Act, 1918, is an Act built up and consolidated from the various Acts relating to Income Tax since 1842.

TAX YEAR.

The year begins on the 6th of April, and ends on the 5th of April following, and these dates denote the period over which the Tax is charged.

ADMINISTRATION.

The Commissioners of Inland Revenue administer and control the Tax, and the Board of Inland Revenue consists of any two or more of these Commissioners whose address is at Somerset House, London, W.C.2.

The work of levying and collecting the Tax locally is performed by Assessors and Inspectors of Taxes.

Assessors—These are not civil servants but are appointed by the General or District Commissioners. The making of annual assessments under Schedule A, B and E, and the issuing of the annual forms of Return are among their main duties.

Inspector of Taxes—These civil servants are officials appointed by the Treasury. They receive and examine the Accounts that are lodged. They examine Assessments before they are submitted to the Commissioners. Among their other duties they amend Assessments, deal with claims, receive notices of appeal and act on behalf of the Crown at the hearing of appeals.

Collectors—In England the collection of the Tax is usually executed by the Assessor, but in Scotland the duty is entrusted to specially appointed Collectors for the various areas.

Tenant or District Commissioners (usually termed the Commissioners)—These are persons of good local standing who act in an Honorary capacity. Their principal duties are to appoint Assessors and Collectors (in certain cases) and additional Commissioners, to sign and allow assessments made by Assessors or Additional Commissioners, and to hear appeals.

Additional Commissioners—The duty of these Commissioners is to make Assessments under Schedule D, with the exception of those cases in which, by request, the Assessment is made by the Special Commissioners. The Additional Commissioners are appointed by the General or District Commissioners.

Special Commissioners—These Commissioners are paid by the Crown. They are civil servants consisting of the Commissioners of Inland Revenue and any other persons the Treasury may appoint. Their duties are to make all Assessments on Railway Companies and Railway Company Employees (Schedule E); to make certain Assessments under Schedule C; to make Assessments under Schedule D or E, where the Taxpayer has so requested; to hear appeals against Assessments made by themselves, and against Assessments under Schedule D or E where an appeal is made direct to them, and to sign and allow Assessments under all Schedules in Northern Ireland. They are also responsible for the whole administration of Surtax.

LIABILITY TO TAX.

A resident in Great Britain is taxable on the whole of his income, whether arising in or out of Great Britain. Certain reliefs may be claimed if income has also borne Income Tax in a British Dominion or in the Irish Free State.

A person not resident in Great Britain is taxable on the whole of his income in Great Britain except on certain War Loans.

RATE OF TAX.

There is a standard rate of Tax which is changed from time to time.

SCHEDULES.

The Taxing Acts classify incomes for assessment under Schedules, and the taxpayer is assessed on his Statutory Income, that is, his income as ascertained under the Rules applicable to the various Schedules.

CLASSIFICATION OF INCOME.

Assessable Income is the Statutory Income, less an allowance of some specified fraction of the Statutory Earned Income

TAXABLE INCOME.

The Taxable Income is the Assessable Income, less personal allowance and allowances in respect of children, dependants, etc.

EARNED INCOME.

Earned Income is the income derived by personal exertion, such as profits from trade,

vocation or employment; and profits from the occupation of land. The profits made by a firm are treated as earned income, as also are interest on partners' capital, pensions to widows, or children, or other dependants, civil list pensions, and the emoluments of rectories and vicarages.

UNEARNED INCOME.

Unearned Income consists of the proceeds of private investments, investments in property, Stocks and Shares, and also the profits of sleeping partners and of Limited Companies, etc.

TAXATION AT THE SOURCE.

In the case of certain classes of income now greatly extended, the Revenue authorities collect the tax not from the recipient of the income, but from the payer. This principle extends to the bulk of wage earners and salaried workers and to Firms, the Firm being assessed in place of the individual partners, and to Limited Companies, the Company being assessed in place of the individual shareholders.

The effect is that the party paying the income is held responsible to the Inland Revenue Authorities for the deductable amount of Tax.

SCHEDULES.

The Taxing Acts classify incomes for assessment under five Schedules.

Schedule A (often termed Landlord's Tax or Property Tax) deals mainly with income arising from the ownership of land and buildings.

Schedule B is the tax on the occupation of land. It is popularly supposed to be limited to farmers, but actually includes in its scope the nominal income arising from the occupation of private grounds, parkland, woodlands, moorlands, sewage farms, etc., as well as the actual income arising from more productive land.

Schedule C—Except where such interest is payable in full, assessments are made in London on the interest paid out of public funds, the tax being deducted by the Bank of England or other body making the payment of interest.

Schedule D—This Schedule deals with all annual income not included in any other Schedule. The tax under this Schedule is classified into six cases.

Schedule E—Relates to incomes of all employed persons.

Schedule A.

This Schedule relates to the ownership of land and buildings. The assessment is made on the full annual rental value assuming that the tenant pays his own rates and the Landlord undertakes to keep the property in repair and to bear Landlord's burdens of tithe and Landlord's rates, if any.

The annual value is usually obtained from the valuations of property made up every five years (except during the War).

Certain deductions are allowed at arriving at the net assessment:—

(*a*) *Repairs Allowance*—On lands, including farm houses and farm buildings, one-eighth of the gross value. On houses and other buildings, if the Landlord is liable for repairs wholly or partly:—

Properties of which the gross value does not exceed £40, one-quarter.

Gross value from £40 to £50—Ten Pounds.

Exceeding £50 but not exceeding £100—One-fifth.

Exceeding £100, one-fifth on the first £100, and one-sixth on the excess over £100.

(*b*) *Land Tax*—The full amount assessed.

(*c*) *Tithe*—The amount actually paid may be deducted.

(*d*) *Drainage Rate.*

Claims for Additional Maintenance.

If the owners of farm land, farm buildings, and houses have expended more on repairs and maintenance than the fixed allowances already mentioned, they may claim a repayment of tax on the excess amount. These claims are based on the average expenditure of the preceding five years.

Schedule B.

Frequently the tax on this Schedule is spoken of as the Farmer's Tax, and it is borne by the occupier. It relates to the occupation of farm lands and farm buildings. The basis of assessment is three times the gross annual value on rents up to £100.

The farmer has a right to be assessed on the basis of his profits under Schedule D by intimating to the Inspector of Taxes in writing before the 5th of June, and, in Scotland, the 5th of August, when his accounts show returns lower than the Schedule B assessment. He must, of course, comply with the regulations relating to the records and other information called for by the Inspector of Taxes.

Schedule C.

This Schedule deals with income from public funds and is usually deducted at the source. The tax is deducted by the financial houses before it reaches the recipient, and if he is entitled to exemption or reduction it is necessary for him to make a claim through the Inspector of Taxes for the District in which he resides.

Schedule D.

This Schedule covers the income from Farms, Trades, Professions, etc. The basis of assessment under Schedule D is the profit of the year preceding the year of assessment. If the year

of assessment is 1944–45, then the accounts for the year 1943–44 form the basis of the return to be made.

Deductions.

The farmer, like other business men, is faced with the problem of appreciating the deductions that he is entitled to claim out of his profits, in arriving at his income.

The following list is a guide to the ordinary expenses of a business that are allowed:—

(1) Any expenses, not being capital expenditure, incurred for the purposes of the business.
(2) Rent, or net Schedule A assessment.
(3) Wages.
(4) Debts proved to be bad.
(5) Repairs to implements and machinery.
(6) General expenses.
(7) Seeds and Manures.
(8) Bank Interest.
(9) Business share of telephone charges.
(10) Business insurances.
(11) Wear and tear allowances on implements and machinery.
(12) Renewal of implements and machinery (where no wear and tear allowance is claimed).
(13) Feeding Stuffs.
(14) Other expenses, the details of which must satisfy the Inspector that they are allowable.
(15) Excess Profits Tax.

Not Allowed.

The following should not be looked upon as a complete list of the expenses that are not allowed to be deducted when computing profits, but as an indication of what is usually left out of the accounts.

(1) Any sums not wholly and exclusively incurred for the purposes of the business.
(2) Any sums paid as salaries to proprietors.
(3) Interest on Capital.
(4) Any Drawings by Partners.
(5) Any sum expended on private or domestic expenses, including cost of home-produced food.
(6) The rent or assessed value of the property unless used for the business.
(7) Any sum paid as Income Tax.
(8) Any losses not connected with the Farm, Trade or Profession, etc.
(9) Any sums invested as Capital in the business, or any capital withdrawn therefrom.
(10) Any sums expended on the improvement of the premises.
(11) Any loss recoverable under an insurance contract.
(12) War Damage contribution.
(13) Loans.
(14) Voluntary payments, such as subscriptions to Charities, etc.

Allowances and Deductions.

Certain reliefs may be claimed by certain taxpayers, at the standard rate, on the incomes of individuals such as:—

I. Earned Income Allowance.
II. Personal Allowance.
III. Housekeeper Allowance.
IV. Children Allowance.
V. Dependent Relative Allowance.
VI. Life Assurance.

Allowances for Wear and Tear on Machinery and Plant.

A wear and tear allowance may be claimed in the returns in respect of Machinery and Plant used in connection with woodlands, and farms where they are assessed under Schedule D. The allowance is calculated on a rate per cent on the diminishing value of the machinery, etc., and any additions to, or sales from the machinery are taken into account.

The farmer may claim Wear and Tear, and in addition he can charge to profits, repairs to plant and machinery, and renewals of loose tools and utensils, but not renewals to plant and machinery.

Obsolescence.

A deduction is allowed against the profits of the farming year where any plant or machinery is discarded, as worn out, and is replaced. The original cost of the plant, less any wear and tear allowance already given, plus the sum realized on the sale of the old plant or machinery.

If the machine cost £100 and the wear and tear allowance amounted to £60, the difference would be £40. If, however, the old machine realized £30, then the £60 plus £30, making £90, would leave £10 which could be charged as an expense against the profits.

Replacement.

The alternative to the above method is one of replacement. The farmer may charge against the profits of the year in which he has replaced the plant, the cost of the new plant and machinery, less the amount he recovered, or is allowed, for the old plant and machinery. Adjustments are made for improvements or additions found in the cost of the new plant and machinery.

INCOME TAX RETURNS.

A person is liable to a penalty for failing to make a return, or if he makes an untrue return, or if he refuses to make a return whether he is chargeable or not.

LAND TAX.

Land Tax is a revenue-producing Tax, charged on the annual value of all manors, lands and tenements, and on all other yearly profits issuing

out of any lands. This tax was first imposed in 1698 and made perpetual in 1798. The 1896 Finance Act fixed the rate of Tax at not less than one penny nor more than one shilling in the £.

The duty is charged on land, and whatever stands thereon, and on tithe. It is regarded more as a rate than a tax, and is an allowable charge against profits.

Like Property Tax it may be deducted by a tenant from his rent (unless he has agreed to bear it).

There are no deductions for repairs.

It is open to any landowner to redeem the tax (i.e., to secure immunity therefrom for the future) by paying twenty-five (*a*) times the tax, according to the last assessment. Applications to redeem should be made to the Registrar of Land Tax, Somerset House, London, or to the Clerk to the Local Commissioners of Taxes.

How Assessed.

A " quota " was originally fixed for each parish, i.e., an amount of Land Tax which it must contribute to the Revenue. This quota is reduced year by year, as redemptions are affected. The rate of tax is fixed annually at such an amount in the pound as, assessed on the unredeemed properties, will produce the present quota and a small sum as remuneration for the Assessor. The rate in the pound must not now exceed 1s., or be less than 1d., on the Gross Value for Schedule A. If a rate of 1s. in the £ will not produce enough money to satisfy the " quota," the Revenue must lose the difference. If 1d. in the £ produces more than the quota, the excess, after the Assessor's remuneration, is applied in redeeming the tax for the parish. In this way the tax has become extinct in many places.

So long as the assessments to Land Tax are equitable, as compared with one another, there is no fixed basis of assessment.

Any person assessed to Land Tax may consult the Clerk to the Commissioners in regard to his assessment and may, at certain times in the year, usually in the summer months, inspect the Land Tax assessment to see if he is overcharged, as compared with other taxpayers. Such times are advertised on the church or chapel doors by means of notices.

Appeals against assessments are heard by the Land Tax Commissioners. Notice of the desire to appeal is to be given to the Clerk to the Commissioners, whose address can be obtained from the Collector or Inspector.

The duty is due and payable on January 1st, and is recoverable by distraint as in the case of Income Tax.

As a fixed quota has to be raised there is no allowance if the land or premises assessed are unoccupied, and if payment is withheld, distraint may be made whenever the land or premises become occupied. In such a case, the new tenant paying the tax or suffering distraint for it, may deduct it from his rent.

A property owner whose total income does not exceed (*a*) £160, may claim exemption from Land Tax by applying to the Inspector of Taxes before paying the duty. Similarly, if his income does not exceed £400 he may claim remission of half the Land Tax.

There is no power to reclaim Land Tax, and it therefore behoves any person assessed, who is entitled either to the exemption or the abatement mentioned, to claim it either before, or as soon as, he receives his first demand note in December.

The Land Tax year runs, not from 6th April of one year to 5th April of the next, as does the Income Tax year, but from 25th March to 24th March. The title to exemption from Land Tax depends upon the amount of the income in what is practically the preceding Income Tax year; thus, the income of the Income Tax year 1944–5 is the basis of the title to exemption for the Land Tax year 1945–6, ending on 24th March, 1946 (*b*).

If building-land is subject to land tax it is obviously advantageous to redeem the tax before building upon it.

TITHE.

Tithe is a portion of the produce of land set aside for the service of the Church. Until the year 1836 a tenth of the produce of land was paid in kind as tithe. The Act of 1836 was amended by many subsequent Acts, ending with the Tithe Act, 1925. This Act revised the principle of the Act of 1836 and stabilized all tithe rent charge for all future years after 1926 at a fixed figure—£105 for £100 tithe rent charge (par value).

In addition to this, it provided for an additional payment of £4 10s. per year per £100 tithe rent charge (par value) in respect of all tithe rent charge vested in Queen Anne's Bounty, so as to establish a sinking fund for its ultimate extinction.

The Act of 1925 was followed by the Tithe Act, 1936—an Act to extinguish tithe rent charge and extraordinary tithe rent charge—to make provision for the redemption and extinguishment of corn rents and similar payments.

This Act was put on the Statute Book following the report of a Royal Commission, appointed on 27th August, 1934, which completed its duties 26th November, 1935.

The Government made a statement (Cmd. 5102) following the Commission's report, as a result of which the tithe-payer is called on to pay £91 11s. 2d. per £100 tithe rent charge over a period of sixty years, after which payments by the tithe-payer cease.

Under the Act of 1936, tithe rent charge must be paid to the Government, and not to the original tithe-owner, and action can be taken to enforce payment just as it can for non-payment of income tax. To provide compensation to the tithe-owners in return for the surrender of this right

to tithe rent charge, the Government issued a 3 per cent Guaranteed stock to which is attached a sinking fund, sufficient to redeem the whole of the principal in sixty years. The sum required for this purpose was about £70,000,000. The payments made by the tithe-payer to the Government are spoken of as redemption annuities.

The owner of land, as has been shown, has to pay income tax on the income from ownership. This income is referred to as the annual value of the land as assessed under Schedule A of the Income Tax Act of 1918.

Section 13 of sub-section 6 of the Tithe Act, 1936, gives the landowner the right to deduct from the income on which he will be called to pay tax, five-sixths, and no more, of each instalment of an annuity.